Exhibit 9

Memorandum

Date: February 17, 1994

To: Distribution

From: Larry Wasicek

Subject: Advanced Thermoplastics - Elastinite Alternative Materials

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Last month I researched advanced thermoplastics as a replacement material to the Elastinite inner member. Attached is a article ADVANCED THERMOPLASTICS Electronics markets hum along while military and aerospace falter I located this article in Modern Plastics mid-November 1993 issue. I noticed that there were several materials that we are currently exploring for shaft and inner member assemblies and other materials that we have not yet investigated. I have contacted the manufactures of these materials and received the material property data information on the resins list in the article. These materials are extrusion grade and are commercially available. I have also included several other data sheets such as Pebax and Eval that are currently being evaluated as shaft and IM alternatives.

I would appreciate you taking the time and analyzing the material property data information. Around the 24 of February I would like to have a meeting regarding material properties for alternative materials for Elastinite replacement. I will voice mail you with further details.

I hope you find this information interesting and helpful. If you have any questions or other ideas please contact me at X53568.

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E. Leopold
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cc:
J. Becker
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ADVANCED THERMOPLASTICS
Electronics markets hum along while military and aerospace falter

Advanced thermoplastics have typically dominated high-end niche markets in which extreme resistance to heat and chemicals are required. These materials, which sell for premium prices and compete with metals and thermosets, have carved out sizable territory in the electrical and electronics sector and in the automotive industry. They have also played an important role in military and aerospace applications, although the sagging economy has tempered these markets. Overall growth rates of advanced thermoplastics are projected at 8-10% annually over the next decade.

Commercial end users of advanced thermoplastics are now battling fierce international competition, while military budgets are steadily shrinking. As a result, cost-squeezed customers are demanding maximum resin performance. In response, advanced thermoplastics suppliers are offering strategic resin formulations to meet these needs.

Advanced thermoplastics are primarily linear polymers with crystalline or amorphous molecular structures. Their general benefits include light weight; simple and fast fabrication (primarily by injection molding, extrusion and thermoforming); excellent corrosion, flame, and wear resistance; good thermal stability; and low moisture pickup. Commercial grades of advanced thermoplastics range in price from about $1.50/lb. to as high as $40/lb. As shown in the table, end users have a rich panoply of resin choices.

Properties of some advanced thermoplastics

Material	Specific gravity	Tensile strength (K psi)	Elongation (%)	Flexural strength (K psi)	Heat deflection temp. (°F)	Chemical resistance	Sources
Polyphenylene sulfide (PPS)	1.3-1.9	10-18	0.5-0.9	26	500	Broad	Phillips (Ryton); Hoechst Celanese (Fortron); GE Plastics (Supec)
Polyetherether ketone (PEEK)	1.3-1.5	13-31	4-9	25-46	300-600	H	ICI (Victrex)
Polyarylether ketone (PAEK)	1.3-1.5	14-38		19-52	338-482	A, AH, B, C, E, K	BASF (Ultrapek)
Polysulfone (PSF)	1.1-1.6	6-18	1.3-6.0	15-22	300-320	AH, K, C	Amoco (Kadel); Amoco (Udel); BASF (Ultrason-S)
Polyethersulfone (PES)	1.4-1.6	12-20	3.0-80	19-28	397-421	A, C, K, E	Amoco (Radel-A); BASF (Ultrason-E)
Polyphenyl-sulfone (PPSU)	1.3	10-12	60-120	13-14	400-415	Broad	Amoco (Radel-R)
Polyetherimide (PEI)	1.3-1.6	15-27	5-8	22-36	405-430	C, K, E	GE Plastics (Ultem)
Polyphthalamide (PPA)	1.3-1.5	15-38	1.6-2.5	29-54	316-574	Broad	Amoco (Amodel)
Liquid crystal polymers (LCP)	1.4-1.9	20-35	1.2-6.9	22-43	350-655	Broad	Amoco (Xydar); Hoechst Celanese (Vectra); Du Pont (HX)

Chemical resistance codes:
A - acids; AH - aromatic hydrocarbons; B - bases; C - chlorinated hydrocarbons; E - esters; H - sulfuric and nitric acids; K - ketones
Source: Vicki P. McConnell

New connector technology spurs gains in electronics

The dominant market for the past two years in advanced thermoplastics has been electrical and electronics, in which 100 million lb. were used worldwide in 1992. The resins went into such parts as connectors, SIMM sockets, chip carriers and coil bobbins. Recent trends have required new resin

By Vicki P. McConnell, Senior Editor, *High Performance Composites*, 1721 N.W. 58th St., Seattle, WA 98107

formulations. For example, the emerging surface-mounting technology (SMT) requires materials with resistance to temperatures of around 500° F. At the same time, new connector designs have become smaller and more complex (especially in pin density), with ever-thinner walls. This has created a demand for new polymers with exceptional dimensional stability and thin-wall strength.

The second biggest outlet for advanced thermoplastics is the automotive industry, which continues its lead in new applications. Inroads are also being made in appliance, medical, chemical processing, food contact and aerospace markets.

Growing surface-mount techniques create new opportunity for PPS

To capitalize on the growth of SMT (estimated global sales volumes increasing 45-65% per year through 1995), producers of polyphenylene sulfide (PPS) have tailored new grades for low flash, improved weld-line strength, and easy or high flow.

Phillips Petroleum offers its low-flash Ryton R4-109 PPS (40% glass filled), while Hoechst Celanese has three low-flash PPS grades in its Fortron E series. The Supec PPS line from GE Plastics includes grade G402, which emphasizes flow and UL 94 V-0 properties. High-ductility grades G301T and G401T are said to boost weld-line strength.

New under-the-hood PPS auto parts outperform metals, but have advantages of lower weight, consolidated design, and resistance to highly corrosive "flex fuels." Supec PPS replaces aluminum in truck generator valves that withstand engine temperatures to 220° F. Fortron has also been successfully used in alternator circuit boards and emission-control pump parts that operate at 10,000 rpm and at temperatures exceeding 300° F. Certain 1995 car models will utilize Ryton BR-105A for high strength and reduced electrostatic discharge in a fuel-system quick connector.

Both Ryton and Fortron PPS stand up better than metals to the corrosive condensates in furnace components. Ryton grades are under development for HVAC products, while a recent Fortron entry (4665) features high-temperature resistance and withstands the high voltages (up to 275 V) required for circuit breakers, testing instruments, and light industrial machinery. Phillips expects PPS worldwide demand to grow steadily by 8-10% per year over the next decade; Hoechst plans to bring its Wilmington, N.C., linear PPS plant onstream in January, 1994; the unit will have a 3,600-ton annual capacity.

PPA is mounting a strong challenge in electronics

Polyphthalamide (PPA), sold under the Amodel label by Amoco Performance Plastics, is designed to exceed the performance of engineering plastics (such as nylon, acetal, polyester, and polycarbonate) at a price less than such competitors as PPS and polyetherimide in certain applications. In SMT-compatible electrical and electronics applications, a recent trend by end users away from costly liquid-crystal polymers (LCPs) may put PPA in a good position as a substitute (though it can't match LCP flow properties). A new 50% glass-filled grade has a relatively modest price (about $2.50/lb.) and is intended to replace thermosets in distribution and control components.

In consumer products, the toughness of PPA has proved an asset in such applications as vacuum-cleaner impellers and electric-drill components. The product's dimensional stability and low moisture absorption make it a good fit in auto-engine components such as motor end frames, intake manifolds, fuel rails and quick connects, air-cooler housings, and a roll-over valve. PPA rod guides on oilfield downhole pumps resist friction and wear; the resin also has potential in new plumbing applications.

Amoco brought a PPA production unit online at its Augusta, GA plant in early 1993, and has entered a recent marketing agreement with Rhone Poulenc to promote Amodel in Europe. The company has also formed a joint venture with Teijin Ltd. to market Amodel and other Amoco products in Japan.

Sulfones gain in automotive, electronic and industrial markets

Sulfone-based polymers are known for their transparency, heat resistance and good electrical properties. Key producers of these materials are Amoco Performance Plastics and BASF. Amoco's Udel polysufone (PSF) is well represented in electrical and electronic, automotive, chemical processing, and cookware applications; it frequently replaces glass in sterilizable medical and dental products. An Amoco blend of Udel PSF with ABS (as well as proprietary resins and mineral fillers) offers PSF-type properties at a slightly lower cost than pure PSF. BASF produces three unreinforced PSF grades in its Ultrason-S line, featuring easy flow and high viscosity; three reinforced grades (10-30% glass-filled) also possess easy flow.

Two grades of polyphenylsulfone (PPSU) are available from Amoco under the Radel-R line: R-5000 for medical products that must resist stress-cracking agents during sterilization; and R-7000 for commercial aircraft interiors. The company's polyethersulfone (PES) resin line is Radel A, available in transparent, opaque, and filled grades. One of the PES products has been used as a high-flow base resin for molded test sockets requiring ribs as thin as 0.010 in.; another has made its way into push-pull telecommunication connector parts.

From BASF, eleven grades of Ultrason-E PES are available, including easy-flow grades for injection molding; higher-viscosity grades for rod, sheet, film, and profile extrusion, or for blow molding; powdered varieties for membrane- or metal-coating applications; and 10-40% glass-filled grades. Properties of the PES resins are retained over a wide temperature range close to the glass transition temperature (225° C); this can be an asset in products requiring repeated steam sterilization.

Polyetherimides edge out metals in places where strength is critical

The hallmark of the polyetherimides is high strength and rigidity, especially under long-term heat exposure. According to GE Plastics, which produces the resin under its Ultem trademark, the global market for polyetherimide (PEI) has been growing by 10-15% per year over the past five years. This rate should be maintained over the next five years, the company predicts. (GE recently expanded its Mt. Vernon, IN, PEI plant by 15% and is weighing a second expansion.)

While Ultem is used in hundreds of consumer, medical, electrical-electronic, aircraft, and automotive parts, the biggest gains are
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Hoechst Celanese
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Some of these are
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optics connectors (w
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and dental equipmer
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Du Pont, meanw
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HX 6000 LCPs feature
aging 482° F), while

biggest gains are reported in metal-replacement applications (mostly involving aluminum and brass in automotive parts). High-flow, glass-reinforced, low-warpage and highly chemical-resistant grades of Ultem are available. For flexible-circuit substrates, Ultem 5000 films are said to offer 50% cost savings over polyimide.

GE blends Ultem PEI and its Lexan polycarbonate in the LTX resin series, introduced in 1992. The blend is touted for its exceptional heat, chemical, and impact resistance. Recent applications of the LTX resins range from microwave cookware to fire helmets. The company also offers copolymers of PEI and silicones, primarily for wire and cable applications.

Liquid-crystal polymers occupy the high end

The LCPs have outstanding strength at extreme temperatures and inherent resistance to the full range of chemicals. As a result, they command fairly steep prices ($7-12/lb.). LCPs exhibit the highest flow rates of any polymer, with virtually no shrinkage; they can also tolerate high levels of regrind.

On Amoco's advanced thermoplastics menu, Xydar glass- and mineral-filled LCPs offer low warpage, good weld-line integrity, enhanced processability, and heat-distortion temperature (HDT) values up to 671° F.

Hoechst Celanese, which forecasts LCP sales growth of greater than 15% in 1993, has introduced an alloy of its Vectra LCP with PPS. The product (grade V-140), which has a HDT of 510° F, is targeted at the electrical-electronic sector and is priced 20% lower than standard Vectra grades. The product joins more than 25 existing grades of Vectra. Some of these are reinforced with glass, carbon, or minerals (fibers or flakes); others are formulated for wear resistance and platability, or contain color concentrates. Vectra has found applications in such products as fiber-optics connectors (where its dimensional stability aids fiber alignments) and dental equipment (where it has a cost advantage over the stainless steel materials used now.)

Du Pont, meanwhile, is seeking appropriate outlets for its HX line of glass-filled LCP resins. The company's HX 6000 LCPs feature a high HDT (averaging 482° F), while HX 7000 resins focus on high melting points (545-555° F). The HX 1000 resins, intended for load-bearing structures, are 30% glass-filled amorphous LCPs with a HDT and glass-transition temperature (Tg) of 356°F; they are said to offer high mechanical properties and a flexural modulus in the 2.5-3.5 MPa range. HX 4000 LCPs provide high resistance to heat and chemicals, along with dimensional stability; they are geared to the automotive sensors market.

Polyetheretherketones can take the heat

When applications demand maximum resistance to high chemical, thermal and mechanical stresses, particularly over the long term, polyetheretherketone (PEEK) is often the material of choice. PEEK allows significant cost savings over metals because it eliminates machining and annealing operations. The leading PEEK producer is ICI, with its Victrex line. Other ketone-based advanced thermoplastics are the polyaryletherketone (PAEK) resins, supplied by BASF under its Ultrapek label, and by Amoco under its Kadel line.

Victrex PEEK has a reported continuous service temperature of 480° F; it retains its mechanical properties to temperatures over 570° F. Primary applications of Victrex are in automotive parts. The 150FC-30 lubricated grade in particular is used for thrust washers and back-up seals in gearboxes and transmissions. Meanwhile, the U.S. Food and Drug Administration has approved Victrex for use in pharmaceutical laboratory instruments and is expected to okay the product for food-contact applications by early 1994.

In 1993, PEEK began to replace metal and nylon in compressor plates for industrial and household equipment. Other gains for PEEK have been made in aerospace applications, such as fixtures, fittings, fuel valves, wing-flap guides, and wheel covers. Automotive applications of PEEK are expected to lead in volume sales for the next two years, with medical equipment also showing hefty gains. ■

BASF

DATE: 2-15-94

FROM: James A. Johnson
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COMPANY:	ACS
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Total Number of Pages (Including cover sheet): 11

RE: PROPERTY SHEETS FOR ULTRAPEIK (PAEK), ULTRASON S (PSU), ULTRASON E (PESU) AND LURAN (SAN).

James A. Johnson
Technical Service Representative

BASF Corporation

BASF

Plastic Materials

Enclosed is the information you requested.

BASF Plastic Materials offers a full line of performance plastics including:

Engineering Thermoplastics

Ultraform®	acetal copolymer	**POM**
Ultramid® A	nylon 66	**PA**
Ultramid® B	nylon 6	**PA**
Ultramid® C	nylon copolymer	**PA**
Ultramid® S	nylon 610	**PA**
Ultramid® T	nylon 6/6 T	**PA**
Ultradur® B	thermoplastic polyester	**PBT**

High Performance Thermoplastics

Ultrapek™	polyaryletherketone	**PAEK**
Ultrason™ E	polyethersulfone	**PES**
Ultrason™ S	polysulfone	**PSU**

Styrene Copolymers

Luran®	styrene acrylonitrile	**SAN**
Luran® S	acrylonitrile/styrene/acrylate	**ASA**
Terlux®	clear MABS- methyl methacrylate/acrylonitrile/butadiene/styrene	**MABS**

Urethane Components

Elastocell®	microcellular polyurethane suspension components

Thank you for you interest in BASF Plastic Materials. If you need additional information, please do not hesitate to call me.

Sincerely,

Diane L. Actman

Diane L. Actman
Marketing Services Manager

Enclosure
DLA/jcm

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Major markets for BASF Plastic Materials Products

Major Markets	Engineering polymers			High temperature polymers			Styrenic copolymers		
	Ultradur®	Ultraform®	Ultramid®	Ultrapek®	Ultrason® E	Ultrason® S	Luran®	Luran® S	Terlux™
	PBT	POM	PA	PAEK	PES	PSU	SAN	ASA	ABS
Transportation	●	●	●	●	●	●	●	●	●
Packaging	●	●	●			●	●		
Electrical/Electronic	●	●	●				●	●	●
Sporting Equipment	●	●	●					●	
Medical			●	●	●	●	●		●
Appliances	●	●	●	●	●	●	●		●
Housewares		●	●		●	●	●		●
Toys	●	●	●				●		
Garden products		●	●					●	
Building Products		●	●					●	
Mechanical parts	●	●	●	●	●	●			

PBT: **Ultradur®** thermoplastic polyesters (polybutylene terephthalate)

POM: **Ultraform®** acetal copolymer

PA: **Ultramid®** nylon (6, 66, 610, copolymers and 6/6T)

PAEK: **Ultrapek®** polyaryletherketone

PES: **Ultrason® E** polyethersulfone

PSU: **Ultrason® S** polysulfone

SAN: **Luran®** styrene acrylonitrile copolymer

ASA: **Luran® S** acrylonitrile/styrene/acrylate

ABS. Clear: **Terlux™** clear acrylonitrile butadiene styrene

This brochure inadvertently identifies the trademark ULTRASON and ULTRAPEK by the symbol ®. ULTRASON and ULTRAPEK are not listed on the Principal Register of the U.S. Patent and Trademark Office. However, BASF has continuously used ULTRASON and ULTRAPEK to identify its products in accordance with BASF's established common law rights in that trademark.

Ultrapek® (PAEK)

Commercial products

A 3000

Typical values (23 °C) for uncoloured products	Unit	Test method DIN/VDE*	Test method ISO/IEC*	Condition[4]	
Mechanical characteristics					
Tensile stress at yield/stress at break*, v = 50 mm/min/v = 5 mm/min*	MPa	53457	527	moist	[illegible]
Tensile strain at break*, v = 50 mm/min/v = 5 mm/min*	MPa	53455	527	moist	118
Tensile creep-modulus, 1000 h, elongation ≤ 0,5 %, +23 °C	%	53455	527	moist	5.2
Tensile creep-modulus, 1000 h, elongation ≤ 0,5 %, +150 °C	MPa	53444	899	moist	3600
Flexural stress at max. force	MPa	53444	899	dry	3150
Flexural strain at max. force	MPa	53452	178	dry	130
Charpy impact resistance[38] +23 °C	%	53452	178	dry	7.5
Charpy impact resistance[38] –30 °C	kJ/m²	–	179/1eU	moist	NB
Charpy notched impact resistance[38] +23 °C	kJ/m²	–	179/1eU	moist	NB
Charpy notched impact resistance[38] –30 °C	kJ/m²	–	179/1eA	moist	7.4
Izod notched impact resistance 1A[34] +23 °C	kJ/m²	–	179/1eA	moist	8.8
Izod notched impact resistance 1A[34] –30 °C	kJ/m²	–	180/1A	moist	8.2
Izod notched impact resistance 4A[5] +23 °C	kJ/m²	–	180/1A	moist	5.6
Izod notched impact resistance 4A[5] –40 °C	kJ/m²	–	180/4A	moist	5.2
Ball indentation hardness H 961/30	kJ/m²	–	180/4A	moist	4.1
	MPa	–	2039/1	dry	220
	–	53505	868		86
Thermal properties					
Flexural temp. at load 1,8 MPa (HDT A)	°C	–	75	dry	170
Flexural temp. at load 0,45 MPa (HDT B)	°C	–	75	dry	>300
Flexural temp. at load 8,0 MPa (HDT C)	°C	–	75	dry	160
Vicat softening temperature, B/50	°C	–	306	dry	>240
Limit of temperature, at few hours operation[11]	°C	–	–	–	>300
Limit of temperature, tensile strength after 20,000 h/180 °C	°C	–	2578	dry	220
Thermal coefficient of linear expansion, longitud. (23–80) °C	10^{-5}/K	53752	–	dry	4.1
Thermal conductivity	W/(m · K)	52612	–	dry	0.29
Specific heat capacity	J/(g · K)	–	1006*	dry	1.4
Electrical properties					
Relative permittivity 100 Hz/1 MHz	–	0303-T4*	250*	dry	3.4/3.3
Dissipation factor at 100 Hz/1 MHz	–	0303-T4*	250*	dry	0.0028/0.005
Volume resistivity	Ω · cm	0303-T30*	93*	dry	>10^{16}
Surface resistance	Ω	0303-T30*	93*	dry	>10^{13}
Electric strength, 1/50	kV/mm	0303-T21*	243/1*	moist	
Comparative tracking index CTI, test solution A	–	0303-T1*	112/A*	moist	CTI 125-0
Comparative tracking index CTI M, test solution B	–	0303-T1*	112/A*	moist	CTI 150-0
Electrolytic corrosion	–	0303-T6*	426*	dry	A1

Characteristics in italics are taken from the plastics database Campus® and are based on the following binding publication from the German plastics standards committee "Guidelines for drafting standards for thermoplastic materials, Part 2: Manufacture of test pieces and determination of properties". CAMPUS is a registered trademark of the CWFG.

For data processing reasons the numbers of the footnotes are not sorted.

8) Conversion factor: from ISO 180 to ASTM D 256 1 kJ/m²:10 J/m

11) Empirical values determined on articles repeatedly exposed to the temperature concerned for several hours at a time over a period of several years. The proviso is that the articles were properly designed and processed

17) Empirical values found on test pieces based on IEC publication 216-1.

31) Partially expected values.

34) Condition: dry = freshly moulded; moist = moist after conditioning in normal climate (DIN 50014-23/50-2) until saturated.

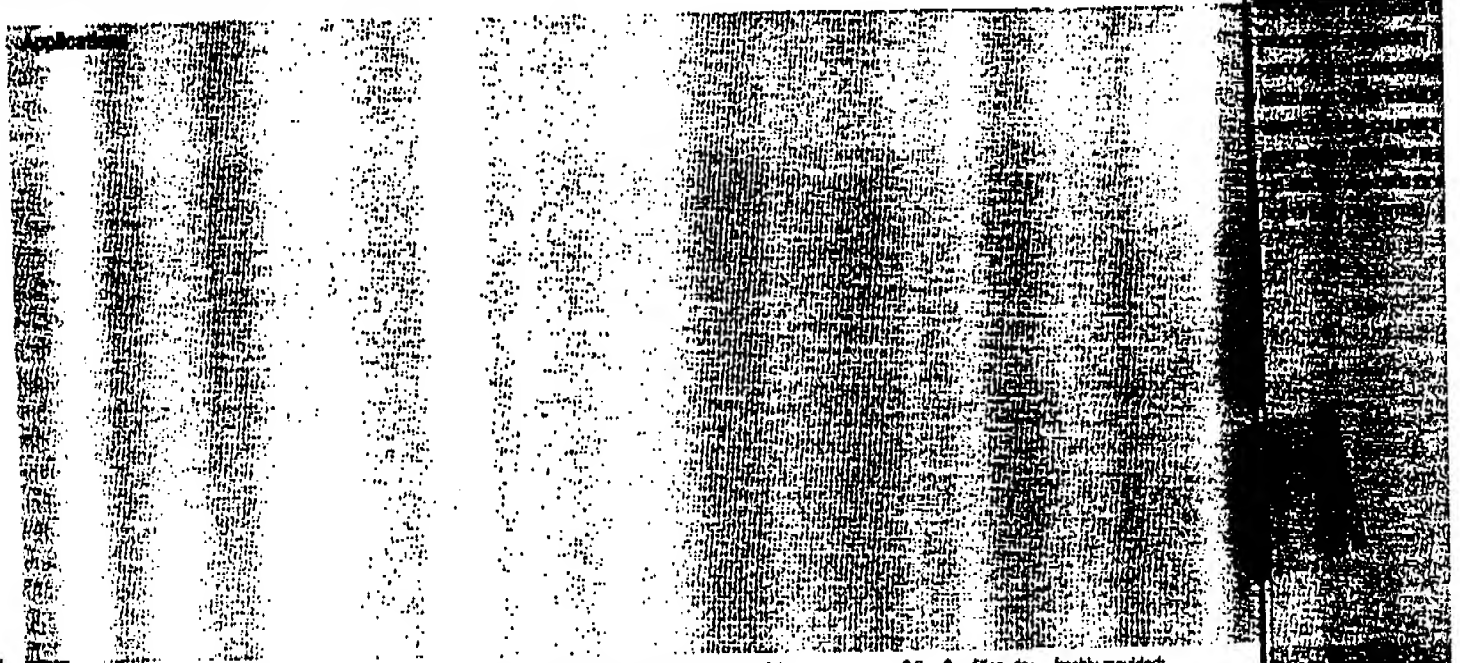
38) NB = no break.

Ultrapek® (PAEK)

Commercial products

Typical values at 23 °C for uncoloured products	Unit	Test method DIN/VDE	Test method ISO/IEC	Condition[34]	
Features					
Symbol		~~ISO 1628~~	~~1043~~		
Density	*g/cm³*	*53479*	*1183*	*dry*	1,3
Reinforcement: Glass fibre (GF), Carbon fibre (CF)	%				
Viscosity number[6]	*ml/g*	–	*1628*	–	128
Colouring: unreinforced (u), black (sw)	%	*53495/1L*	–	–	0,6
Water absorption, saturation in water at 23 °C	%				
Moisture absorption, saturation at standard conditioning atmosphere (23 °C/50 % r.h.	%				
Processing					
Method of processing :					
Injection moulding (M), Extrusion (E), Film extrusion (F), Blow moulding (B)					M,E,F
Melting point, DSC	°C	–	3146	–	381
Glass transition temperature	°C		4006		
Melt volume rate MVR 400/10	*ml/10 min*	–	*1133*	–	40
Melt volume rate MVR 400/5	*cm³/10 min*		*1133*		
Melt temperature range, injection moulding	°C	–	–	–	390 – 420
Mould temperature range	°C				
Moulding shrinkage, free, longitud./transvers.[5]	%	–	–	dry	1,4/1,53
Melt temperature range, extrusion	°C				
Major performances					
Flammability according to UL Standard					
at 0,8 mm thickness	*class*	–	*UL94*	–	94V-0
at 1,6 mm thickness	*class*	–	*UL94*	–	
Flammability of insulating materials for electrical applications					BH2-4mm
Method BH	class	–	707	–	
Method BF	class		707		BF2

Applications



Characteristics in italics are taken from the plastics database Campus® and are based on the following binding publication from the German plastics standards committee "Guidelines for drafting standards for thermoplastic materials, Part 2: Manufacture of test pieces and determination of properties". CAMPUS is a registered trademark of the CWFG.

For data processing reasons the numbers of the footnotes are not sorted.

5) Plate with film gate, dimensions (110 · 110 · 2) mm, longitudinal = in flow direction, transversal = crosswise at the flow direction.

6) Viscosity number, solution 0,005 g/ml

34) Condition: dry = freshly moulded; moist = moist after conditioning in normal climate (DIN 50014-23/50-2) until saturated.

Classification: unreinforced reinforced products

Ultrason® (PLSU/PSU)

Commercial and development products

S3010

Former designation: S 3000/KR 4042

Typical values at 73 °F for uncolored products	Unit	Test method ISO	Test method ASTM	Condition of specimen dr = dry m = moist	
Features					
Processing technique: injection molding (M), extrusion (E) film extrusion (F), blow molding (B)	–	–	–	–	M, E, F, B
● Mass density	g/cm³	1183	D 792	dr	1.24
Reinforcement/fillers: glass fibers (GF), mineral (M)	%	–	–	–	
● Melt volume index MVI 572 / 21.6	cm³/(10 min)	1133	D 1238[a]	–	30
● Melt volume index MVI 680 / 10	cm³/(10 min)	1133	D 1238[a]	–	80
● Viscosity number VN[b]	ml/g	1628	D 1238	–	72
● Moisture absorpt. in standard laboratory atm. of 73 °F/50 % RH	%	62	D 570	dr	0.2
● Water absorption to saturation at 73 °F	%	62	D 570	dr	0.8
Physical form					
● Granules	–	–	–	–	●
Coloration					
Natural color	–	–	–	–	●
Colored	–	–	–	–	● on request
Specialty colorants	–	–	–	–	● on request
Black	–	–	–	–	● on request
Processing					
Flow	%	–	–	–	
Processing shrinkage Restricted: Machine/transv. direction[c]	10^{-3}in/in.	–	–	–	6.6/8.9
Processing shrinkage Free to shrink: Machine/transv. direction[d]	10^{-3}in/in.	–	–	–	4.9/5.9
Injection temperature	°F	–	–	–	680
Mold temperature	°F	–	–	–	320
Injection molding					
Injection temperature	°F	–	–	–	625–680
Mold temperature	°F	–	–	–	250–320
Applications					High viscosity product for injection molding/extrusi

● Properties printed in blue have been entered in the Campus® data bank based on the guidelines for achieving full and Auserarbeitung von Normen über thermoplast-Formmasse Teil 2: Herstellung von Probekörpern und Bestimmung von Eigenschaften, published by the West German committee of plastics standards.
Campus = registered trademark of CIT

a D 1238 gives MFI results (g/10 min) and not MVI (cm³/10 min) results

b Measured at a concentration of 1 % in a 1 to 1 mixture of phenol/1,2-dichlorobenzene

c Specimen basis, thickness t = 1.5 mm as shown in Fig. 36 on page 32 of the Ultrason booklet

d Typical values determined on 110 x 110 x 2 mm sheet specimens, film gate

Classification: unreinforced reinforced products

Ultrason® (PESU/PSU)

Commercial and development products

S 3010

Former designation S 3000/KR 4042

Typical values at 73 °F for uncolored products		Unit	Test method ISO	Test method IEC*	Test method ASTM	Condition of specimen dr = dry m = moist	
Mechanical properties							
• Tensile strength at yield (50 mm/min)		psi	527		D 638	m	11 500
• Elongation at yield (50 mm/min)		%	527		D 638	m	5.7
• Ultimate elongation		%	527		D 638	m	60–85
• Tensile strength (5 mm/min)		psi	527		D 638	m	
• Modulus of elasticity in tension (1 mm/min)		psi	527		D 638	m	390 000
• Creep modulus in tension (0.5 %; 1 h)	73 °F	psi	899		D 2990	m	360 000[a]
• Creep modulus in tension (0.5 %; 1000 h)	73 °F	psi	899		D 2990	m	360 000[a]
• Creep modulus in tension (0.5 %; 1000 h)	285 °F/320 °F[b]	psi	899		D 2990	dr	115 000[a]
Flexural strength		psi	178		D 790 M	m	17 500
Flexural modulus		psi	178		D 790 M	m	370 000
• Izod impact resistance	73 °F	ft.lb/in.	–		D 256/Method E	m	n.b.
• Izod impact resistance	–22 °F	ft.lb/in.	–		D 256/Method E	m	n.b.
• Izod notched impact resistance	73 °F	ft.lb/in.	–		D 256/Method A	m	1.2
• Izod notched impact resistance	–22 °F	ft.lb/in.	–		D 256/Method A	m	1.3
Kinetic energy required to cause failure in falling dart test[c] W_{50}	73 °F	ft.lbf.	6603-1		D 3029	m	66
	–22 °F	ft.lbf.	6603-1		D 3029	m	52
Rockwell hardness		class	–		D 785	m	M 69
Thermal properties							
• Heat distortion temperature HDT/A	(264 psi)	°F	75		D 648	dr	340
• Heat distortion temperature HDT/B	(66 psi)	°F	75		D 648	dr	360
• Vicat softening temperature A/50	(10 N) 2.25 lbf.	°F	306		D 1525	dr	374
• Vicat softening temperature B/50	(50 N) 11.25 lbf.	°F	306		D 1525	dr	361
• Thermal coefficient of linear exp., machine direction		10^{-6} °F^{-1}	–		D 696	dr	31
Temperature endurance profile – up to a few hours		°F	Empirical values obtained on moldings in accordance with IEC-publication 216-1			–	355
– 20 000 hours (retention of 50 % of initial tensile strength)		°F				–	320[a]
Dielectric properties							
• Dielectric constant 50 Hz		–	250*		D 150	m	3.2
• Dielectric constant 1 MHz		–	250*		D 150	m	3.2
• Dissipation factor 50 Hz		10^{-3}	250*		D 150	m	0.8
• Dissipation factor 1 MHz		10^{-3}	250*		D 150	m	5.5
• Dielectric strength K 20/P 50		Volts/mil	243*		–	m	2550
• Comparative tracking index CTI, CTI 100 droplet value		–	112*		D 3638	dr/m	125–0
• Comparative tracking index CTI M, CTI M 100 droplet value		–	112*		D 3638	dr/m	125 M–0
• Volume resistivity		Ω · cm	93*		D 257	dr	≥ 10^{16}
• Surface resistivity		Ω	93*		D 257	dr	≥ 10^{14}
Optical properties							
• Light transmittance		%	–		–	–	70–85
• Refractive index		–	489		D 542	–	1.63
Fire resistance							
• Limited oxygen index		%	–		D 2863	–	30
• UL-standard 94 (thickness 1/64 inch)		class				–	
• UL-standard 94 (thickness 1/32 inch)		class				–	HB[e]
• UL-standard 94 (thickness 1/16 inch)		class		UL-standard 94		–	HB[e]
• UL-standard 94 (thickness 1/8 inch)		class				–	V-2[e]

• Properties printed in blue have been entered in the Campus® data bank based on the guidelines: "Richtlinie für die Auswertung von Normen über Thermoplast-Formmassen. Teil 2: Herstellung von Probekörpern und Bestimmung von Eigenschaften", published by the West German committee on plastics standards.
Campus = registered trademark of CWFG

a Anticipated values

b Ultrason S-products 285 °F / Ultrason E-products 320 °F

e Specimen boxes, thickness t = 1.5 mm as shown in Fig. 36 on page 32 of the Ultrason booklet

Ultrason (PESU/PSU)

Commercial and development products

Classification: unreinforced – reinforced products

E 3010

Former designation: E 3000

Typical values at 73 °F for uncolored products		Unit	Test method ISO	Test method ASTM	Condition of specimen dr = dry m = moist	
Mechanical properties						
• Tensile strength at yield (50 mm/min)		psi	527	D 638	m	13 000
• Elongation at yield (50 mm/min)		%	527	D 638	m	6.7
• Ultimate elongation		%	527	D 638	m	15–40
• Tensile strength (5 mm/min)		psi	527	D 638	m	
• Modulus of elasticity in tension (1 mm/min)		psi	527	D 638	m	410 000
• Creep modulus in tension (0.5 %; 1 h)	73 °F	psi	899	D 2990	m	410 000
• Creep modulus in tension (0.5 %; 1000 h)	73 °F	psi	899	D 2990	m	390 000
• Creep modulus in tension (0.5 %; 1000 h)	285 °F/320 °F [b]	psi	899	D 2990	dr	145 000
Flexural strength		psi	178	D 790 M	m	18 500
Flexural modulus		psi	178	D 790 M	m	370 000
• Izod impact resistance	73 °F	ft.lb/in.	–	D 256/Method E	m	n.b.
• Izod impact resistance	– 22 °F	ft.lb/in.	–	D 256/Method E	m	
• Izod notched impact resistance	73 °F	ft.lb/in.	–	D 256/Method A	m	1.5
• Izod notched impact resistance	– 22 °F	ft.lb/in.	–	D 256/Method A	m	1.6
Kinetic energy required to cause failure in falling dart test [c] W_{50}	73 °F	ft.lbf.	6603-1	D 3029	m	59
	– 22 °F	ft.lbf.	6603-1	D 3029	m	44
Rockwell hardness		class	–	D 785	m	M 85
Thermal properties						
• Heat distortion temperature HDT/A	(264 psi)	°F	75	D 648	dr	383
• Heat distortion temperature HDT/B	(66 psi)	°F	75	D 648	dr	410
• Vicat softening temperature A/50	(10 N) 2.25 lbf.	°F	306	D 1525	dr	428
• Vicat softening temperature B/50	(50 N) 11.25 lbf.	°F	306	D 1525	dr	419
• Thermal coefficient of linear exp., machine direction		10^{-5} °F^{-1}	–	D 696	dr	3.1
Temperature endurance profile – up to a few hours		°F	Empirical values obtained on mouldings in accordance with IEC-publication 216-1		–	430
– 20 000 hours (retention of 50 % of initial tensile strength)		°F			–	355
Dielectric properties						
• Dielectric constant 50 Hz		–	250*	D 150	m	3.6
• Dielectric constant 1 MHz		–	250*	D 150	m	3.5
• Dissipation factor 50 Hz		10^{-3}	250*	D 150	m	1.7
• Dissipation factor 1 MHz		10^{-3}	250*	D 150	m	11
• Dielectric strength K 20/P 50		Volts/mil	243*	–	m	2000
• Comparative tracking index CTI, CTI 100 droplet value		–	112*	D 3638	dr/m	150–0
• Comparative tracking index CTI M, CTI M 100 droplet value		–	112*	D 3638	dr/m	
• Volume resistivity		Ω · cm	93*	D 257	dr	≥ 10^{16}
• Surface resistivity		Ω	93*	D 257	dr	≥ 10^{14}
Optical properties						
• Light transmittance		%	–	–	–	70–85
• Refractive index		–	489	D 542	–	1.65
Fire resistance						
• Limited oxygen index		%	–	D 2863	–	38
• UL-standard 94 (thickness 1/64 inch)		class	UL-standard 94		–	V-1 [a]
• UL-standard 94 (thickness 1/32 inch)		class			–	V-0 [a]
• UL-standard 94 (thickness 1/16 inch)		class			–	V-0 [a]
• UL-standard 94 (thickness 1/8 inch)		class			–	V-0 [a]

• Properties printed in blue have been entered in the Campus® data bank based on the guidelines: "Richtlinie für die Auswertung von Normen über Thermoplast-Formmassen, Teil 2: Herstellung von Probekörpern und Bestimmung von Eigenschaften", published by the West German committee on plastics standards.
Campus = registered trademark of CIMDATA

a Anticipated values

b Ultrason S-products 285 °F / Ultrason E-products 320 °F

c Specimen base, thickness t = 1.5 mm as shown in Fig. 38 on page 82 of the Ultrason booklet

Ultrason (PESU/PSU)

Commercial and development products

Classification: unreinforced + reinforced products

E 3010

Former designation: E 3000

Typical values at 73 °F for uncolored products	Unit	Test method ISO	Test method ASTM	Condition of specimen dr = dry m = moist	
Features					
Processing technique: injection molding (M), extrusion (E) film extrusion (F), blow molding (B)	–	–	–	–	M, E, F, B
• Mass density	g/cm³	1183	D 792	dr	1.37
Reinforcement/fillers: glass fibers (GF), mineral (M)	%	–	–	–	
• Melt volume index MVI 572 / 21.6	cm³/(10 min)	1133	D 1238[a]	–	3
• Melt volume index MVI 680 / 10	cm³/(10 min)	1133	D 1238[a]	–	30
• Viscosity number VN[b]	ml/g	1628	D 1238	–	68
• Moisture absorpt. in standard laboratory atm. of 73 °F/50 % RH	%	62	D 570	dr	0.7
• Water absorption to saturation at 73 °F	%	62	D 570	dr	2.1
Physical form					
• Granules	–	–	–	–	●
Coloration					
Natural color	–	–	–	–	●
Colored	–	–	–	–	● on request
Specialty colorants	–	–	–	–	● on request
Black	–	–	–	–	● on request
Processing					
Flow	%	–	–	–	
Processing shrinkage Restricted: Machine/transv. direction[c]	10^{-3} in/in.	–	–	–	7.5/9.1
Free to shrink: Machine/transv. direction[d]	10^{-3} in/in.	–	–	–	7.3/8.3
Injection temperature	°F	–	–	–	700
Mold temperature	°F	–	–	–	320
Injection molding					
Injection temperature	°F	–	–	–	660–735
Mold temperature	°F	–	–	–	285–320
Applications					High viscosity product for injection molding/extrusion

● Properties printed in blue have been entered in the Camoes® data bank based on the guidelines: "Richtlinie für die Aufbereitung von Normen über Thermoplast-Formmassen. Teil 2: Herstellung von Probekörpern und Bestimmung von Eigenschaften", overseen by the West German committee on plastics standards.

Camoes – registered trademark of CWFG

a ISO 1238 gives MFI results (g/10 min) and not MVI (cm³/10 min) results

b Measured at a concentration of 1 % in a 1 to 1 mixture of phenol/1,2-dichlorbenzene

c Specimen bases, thickness t = 1.5 mm as shown in Fig. 36 on page 32 of the Ultrason booklet

d Typical values determined on 110 x 110 x 2 mm sheet specimens, film gate

Luran (SAN)

Commercial and development products

Classification: unreinforced reinforced products

388 S

Typical values at 23 °C for uncoloured products		Unit	Test method ISO / IEC*	DIN / VDE*	Specimens (dimensions in mm)	
Features						
Processing technique: injection moulding (M), extrusion (E)		–	–	–	–	M/E
● Mass density		g/cm³	1183	53 479-A	–	1.08
Reinforcement/fillers: glass fibres (GF)		%	–	–	–	
Mechanical properties						
● Tensile strength (5 mm/min)		N/mm²	527	53 455	ISO 3167	84
● Ultimate elongation		%	527	53 455	bar	4
● Modulus of elasticity in tension (1 mm/min)		N/mm²	527	53 457	specimen	3900
Flexural strength		N/mm²	178	53 452	50 × 6 × 4	140
Charpy impact resistance	+ 23 °C	kJ/m²	179/2D	53 453	50 × 6 × 4	20
Charpy impact resistance	– 40 °C	kJ/m²	179/2D	53 453		20
● Izod notched impact resistance	– 23 °C	kJ/m²	180/1A	–	80 × 10 × 4	2.5
Charpy notched impact resistance	+ 23 °C	kJ/m²	179	53 453	50 × 6 × 4	2.5
Ball indentation (H 358/30)		N/mm²	2039-1	53 456	≥ 10 × ≥ 10 × 4	175
Rockwell hardness		Rating	2039/2	–	–	M 86
Thermal properties						
● Heat distortion temperature HDT/A	(1.8 N/mm²)	°C	75	53 461	110 × 10 × 4	99
● Heat distortion temperature HDT/B	(0.45 N/mm²)	°C	75	53 461	or 80 × 10 × 4	103
● Vicat softening temperature B/50	(50 N)	°C	306	53 460	≥ 10 × ≥ 10 × 4	107
● Thermal coefficient of linear exp., machine direction 23–80 °C		10^{-4}/K	–	53 752		0.7
Maximum service temperature[1]		°C	empirical values		–	85
Thermal conductivity, Method A		W/(K m)	–	52 612	250 × 250 × 10	0.17
Dielectric properties[2]						
● Dielectric constant 50 Hz		–	250*	0303-T4*	80 × 80 × 1	3.0
● Dielectric constant 1 MHz		–	250*	0303-T4*		2.8
● Dissipation factor 50 Hz		10^{-4}	250*	0303-T4*		50
● Dissipation factor 1 MHz		10^{-4}	250*	0303-T4*		80
● Dielectric strength[3] K 20/P 50		kV/mm	243*	0303-T2*		95
● Comparative tracking index CTI, CTI 100 droplet value		–	112*	0303-T1*	≥ 15 × ≥ 15 × 4	475
● Comparative tracking index CTI M, CTI M 100 droplet value		–	112*	0303-T1*		250
● Volume resistivity		Ω cm	93*	0303-T3*	80 × 80 × 1	10^{16}
● Surface resistivity		Ω	93*	0303-T3*		10^{14}
Optical properties						
● Refractive index		–	489	53 491	1 mm thickness	1.580
Fire resistance						
● UL standard 94: 1.6 mm thickness		class	UL Standard 94		127 × 12.7 × th.	94 HB
● 0.8 mm thickness		class				94 HB
Testing electric insulating materials	Method BH	rating	707*	0304-T3*	125 × 10 × 4	BH 3–20 mm/min
	Method FH	rating	707*	0304-T3*	125 × 13 × 3	FH 3–25 mm/min

● Properties [illegible] have been entered in the Campus[illegible] data bank based on the [illegible] [illegible]

1 Empirical values determined on articles repeatedly subjected to the temperature concerned for several hours at a time over a period of several years. The proviso is that the articles were properly designed and processed according to our recommendations.

2 Measured on specimens that were compression moulded at 200 – 220 °C and conditioned in a standard laboratory atmosphere of 23 °C and 50 % relative humidity (DIN 50 014).

3 Measured on specimens of [illegible] mm thickness with ball-and-plate electrodes

Luran (SAN)

Commercial and development products

Classification: unreinforced – reinforced products

388 S

Typical values at 23 °C for uncoloured products	Unit	Test method ISO	Test method DIN	Specimens (dimensions in mm)	
Features					
Processing technique: injection moulding (M), extrusion (E)	–	–	–	–	M/E
• Mass density	g/cm³	1183	53 479-A	–	1.08
Reinforcement/fillers: glass fibres (GF)	%	–	–	–	
• Melt volume index MVI 200/21.6[1]	cm³/10 min	1133	53 735	moulding	8
• Melt volume index MVI 220/10[1]	cm³/10 min	1133	53 735	compound	7
Apparent density	g/cm³	–	53 466	–	0.65
• Water absorption to saturation at 23 °C	%	62	53 495/1L	80 × 80 × 1	0.3
Physical form					
• Granules	–	–	–	–	●
Coloration					
Natural colour	–	–	–	–	●
Water-clear	–	–	–	–	●
Transparent shades	–	–	–	–	●
Opaque shades	–	–	–	–	●
Specialty colorants	–	–	–	–	●
Black	–	–	–	–	●
Processing					
Processing features	–	–	–	–	
Flow	–	–	–	–	
Processing shrinkage, free	%	–	–	–	0.3–0.7
Injection moulding					
Injection temperature	°C	–	–	–	220–270
Mould temperature	°C	–	–	–	40–80
Extrusion					
Stock temperature:					
Tubes	°C	–	–	–	220–240
Semi-finished articles	°C	–	–	–	220–240

Applications

Product with enhanced resistance to chemicals and increased mechanic strength.

Accessories for kitchen appliances, mixing bowl filters, stirrers, coffee fill instrument panel covers, sanitary fittings and dial housings.

● Properties printed in blue have been [illegible] data based on the guide-[illegible] Arbeitsring für die Ausbildung von Normen [illegible] Herstellung von Prüfkörpern und deren [illegible] Federal Republic of Germany) [illegible]

1 According to DIN 16773 Specification for SAN, the MVI is determined at 220 °C/10 kg

Classification: unreinforced reinforced products | 368 R

Luran (SAN)

Commercial and development products

Typical values at 23 °C for uncoloured products	Unit	Test method ISO	DIN	Specimens (dimensions in mm)	
Features					
Processing technique: Injection moulding (M), extrusion (E)	–	–	–	–	M/E
● Mass density	g/cm³	1183	53 479-A	–	1.08
Reinforcement/fillers: glass fibres (GF)	%	–	–	–	
● Melt volume index MVI 200/21.6[1]	cm³/10 min	1133	53 735	moulding compound	12
● Melt volume index MVI 220/10[1]	cm³/10 min	1133	53 735	moulding compound	10
Apparent density	g/cm³	–	53 466	–	0.65
● Water absorption to saturation at 23 °C	%	62	53 495/1L	80 × 80 × 1	0.2
Physical form					
● Granules	–	–	–	–	●
Coloration					
Natural colour	–	–	–	–	●
Water-clear	–	–	–	–	●
Transparent shades	–	–	–	–	●
Opaque shades	–	–	–	–	●
Specialty colorants	–	–	–	–	●
Black	–	–	–	–	●
Processing					
Processing features	–	–	–	–	
Flow	–	–	–	–	
Processing shrinkage, free	%	–	–	–	0.3–0.7
Injection moulding					
Injection temperature	°C	–	–	–	220–270
Mould temperature	°C	–	–	–	40–80
Extrusion					
Stock temperature:					
Tubes	°C	–	–	–	220–240
Semi-finished articles	°C	–	–	–	220–240
Applications					General-purpose produ[ct] with well-balanced properties. Sanitary fittings, cosme[tic] boxes, refrigerator fittin[gs], crockery, transparent c[overs] for electric meters, batt[ery] cases, and dialyzer housings.

● Properties printed in blue have been entered in the Campus® data base based on the guidelines "Richtlinien für die Anwendung von Normen über Thermoplast-Formmassen, Teil 2 Herstellung von Probekörpern und Bestimmung von Eigenschaften"

1 According to the DIN 16775 Specification for SAN, the MVI is determined at 220 °C/10 kg.

Luran (SAN)

Commercial and development products

Classification: unreinforced reinforced products

368 R

Typical values at 23 °C for uncoloured products		Unit	Test method ISO IEC*	DIN VDE*	Specimens (dimensions in mm)	368 R
Features						
Processing technique: injection moulding (M), extrusion (E)		–	–	–	–	M/E
● Mass density		g/cm³	1183	53 479-A	–	1.08
Reinforcement/fillers: glass fibres (GF)		%	–	–	–	
Mechanical properties						
● Tensile strength (5 mm/min)		N/mm²	527	53 455	ISO 3167 bar specimen	75
● Ultimate elongation		%	527	53 455		3
● Modulus of elasticity in tension (1 mm/min)		N/mm²	527	53 457		3800
Flexural strength		N/mm²	178	53 452	50 × 6 × 4	125
Charpy impact resistance	+ 23 °C	kJ/m²	179/2D	53 453	50 × 6 × 4	18
Charpy impact resistance	− 40 °C	kJ/m²	179/2D	53 453		16
● Izod notched impact resistance	+ 23 °C	kJ/m²	180/1A	–	80 × 10 × 4	2.0
Charpy notched impact resistance	+ 23 °C	kJ/m²	179	53 453	50 × 6 × 4	2.0
Ball indentation (H 358/30)		N/mm²	2039-1	53 456	≥10 × ≥10 × 4	165
Rockwell hardness		Rating	2039/2	–	–	M 83
Thermal properties						
● Heat distortion temperature HDT/A	(1.8 N/mm²)	°C	75	53 461	110 × 10 × 4 or 80 × 10 × 4	98
● Heat distortion temperature HDT/B	(0.45 N/mm²)	°C	75	53 461		102
● Vicat softening temperature B/50	(50 N)	°C	306	53 460	≥ 10 × ≥ 10 × 4	106
● Thermal coefficient of linear exp., machine direction 23–80 °C		10^{-4}/K	–	53 752		0.7
Maximum service temperature[1]		°C	empirical values		–	85
Thermal conductivity, Method A		W/(K m)	–	52 612	260 × 260 × 10	0.17
Dielectric properties[2]						
● Dielectric constant 50 Hz		–	250*	0303-T4*	80 × 80 × 1	3.0
● Dielectric constant 1 MHz		–	250*	0303-T4*		2.7
● Dissipation factor 50 Hz		10^{-4}	250*	0303-T4*		40
● Dissipation factor 1 MHz		10^{-4}	250*	0303-T4*		70
● Dielectric strength[3] K 20/P 50		kV/mm	243*	0303-T2*		95
● Comparative tracking index CTI, CTI 100 droplet value		–	112*	0303-T1*	≥ 15 × ≥ 15 × 4	425
● Comparative tracking index CTI M, CTI M 100 droplet value		–	112*	0303-T1*		200
● Volume resistivity		Ω cm	93*	0303-T3*	80 × 80 × 1	10^{16}
● Surface resistivity		Ω	93*	0303-T3*		10^{14}
Optical properties						
● Refractive index		–	489	53 491	1 mm thickness	1.569
Fire resistance						
● UL standard 94: 1.6 mm thickness		class	UL Standard 94		127 × 12.7 × th	94 HB
● 0.8 mm thickness		class				94 HB
Testing electric insulating materials	Method BH	rating	707*	0304-T3*	125 × 10 × 4	BH 3–20 mm/min
	Method FH	rating	707*	0304-T3*	125 × 13 × 3	FH 3–25 mm/min

● Properties printed in blue have been entered in the Campus* data bank based on the ...
Richtlinie für die Ausarbeitung von Normen über Thermoplast-Formmassen - Teile 1: Herstellung von Probekörpern und Bestimmung von Eigenschaften published by the West German committee on plastics standards
Campus = registered trademark of CWFG

1 Empirical values determined on articles repeatedly subjected to the temperature concerned for several hours at a time over a period of several years. The proviso is that the articles were properly designed and processed according to our recommendations.

2 Measured on specimens that were compression moulded at 200 – 220 °C and conditioned in a standard laboratory atmosphere of 23 °C and 50 % relative humidity (DIN 50 014).

VICTREX® PEEK

Introduction

Victrex® PEEK is a linear aromatic polymer, a poly-(aryletherketone).

The material has a balance of high temperature mechanical properties, chemical resistance and processability which makes it unique.

Summary of Key Properties

Victrex® PEEK is a semi-crystalline polymer. Its most important characteristics are:

1. High Temperature Performance: Victrex® PEEK has an estimated continuous service temperature (UL746B method) of 260°C (500°F) with excellent mechanical properties retained to temperatures over 300°C (570°F).

2. Chemical Resistance: Victrex® PEEK is insoluble in all common solvents and, being semi-crystalline, has excellent resistance to a very wide range of organic and inorganic liquids.

3. Hydrolysis Resistance: Victrex® PEEK can be used for thousands of hours at temperatures in excess of 250°C (480°F) in steam or high pressure water environments without any significant degradation in properties.

4. Strength & Toughness: Victrex® PEEK has exceptionally high strength properties combined with good toughness over a wide range of temperatures.

5. Wear Resistance: Victrex® PEEK and blends of Victrex® PEEK with other lubricious materials offer excellent tribological properties under a wide range of conditions.

6. Electrical: The excellent electrical properties of Victrex® PEEK remain stable over a wide range of temperatures and frequencies.

7. Flammability: Victrex® PEEK has a V-0 flammability rating down to 1.45 mm (0.057 in) without the use of additives. (Underwriters' Laboratories test results).

8. Smoke and Toxic Gas Emission: The levels of smoke and toxic acid gas released during combustion are extremely low for a thermoplastic material.

9. Radiation Resistance: The resistance of Victrex® PEEK to gamma radiation at high dose levels is exceptional for a plastics material.

10 Processing: Victrex® PEEK is easily processed using a wide range of conventional thermoplastic processing equipment. Injection molded items do not require post-treatment.

Victrex® PEEK Sales Range

Powder	
150P	Low viscosity for extrusion compounding.
450P	Standard viscosity for extrusion compounding.
Fine Powder	
150PF	Low viscosity for blending and powder coating.
450PF	Standard viscosity for compression molding, blending, and powder coating.
Granules	
150G	Easy flow for injection molding of thin sections and complex parts.
450G	General purpose for injection molding and extrusion.
Glass Filled	
150GL30	Easy flow, 30% glass fiber reinforced for injection molding.
450GL30	General purpose, 30% glass fiber reinforced for injection molding and extrusion.
Carbon Filled	
150CA30	Easy flow, 30% carbon fiber reinforced for injection molding.
450CA30	Standard viscosity, 30% carbon fiber reinforced for injection molding.
Lubricated	
150FC30	Easy flow, 30% carbon/PTFE filler combination for injection molding.
450FC30	Standard viscosity, 30% carbon/PTFE filler combination for injection molding.
Depth Filtered	
381G	Grade for wire coating, film and monofilament.

printed

GENERAL PROPERTIES OF VICTREX® PEEK

Category	Method	Units	381G
General			
◆ Relative Density: (Crystalline)	ASTM D792		1.3
(Amorphous)	ASTM D792		1.26
◆ Typical level of crystallinity		%	30-35
◆ Mold shrinkage		%	1.0-1.3
◆ Water absorption: 24hr. @ 73°F	ASTM D570	%	0.5
Equilibrium @ 73°F	ISO R62A	%	0.5
Mechanical			
◆ Tensile strength: @ 73°F (yield)	ASTM D638 (5mm/min)	psi	13,500
@ 482°F (yield)	ASTM D638 (5mm/min)	psi	1,740
◆ Elongation at break @ 73°F	ASTM D638 (5mm/min)	%	50
◆ Elongation at yield @ 73°F	ASTM D638 (5mm/min)	%	4.9
◆ Flexural modulus: @ 73°F	ASTM D790	psi	594,000
@ 248°F	ASTM D790	psi	580,100
@ 428°F	ASTM D790	psi	43,500
◆ Flexural strength: @ 73°F	ASTM D790	psi	24,650
@ 248°F	ASTM D790	psi	14,500
@ 482°F	ASTM D790	psi	1,800
◆ Izod impact strength @ 73°F: Notched 0.01 in radius, 0.14 in depth	ASTM D256	ft.-lb./in.	1.57
Unnotched	ASTM D256	ft.-lb./in.	No Break
Thermal			
◆ Melt Point	DSC	°F	644
◆ Glass transition temperature, Tg (onset value)	DSC	°F	289
◆ Coefficient of thermal expansion: < Tg	ASTM D696	10^{-5} °F^{-1}	2.6
> Tg	ASTM D696	10^{-5} °F^{-1}	6
◆ Heat distortion temperature, 264 psi	ASTM D648	°F	320
◆ UL continuous use temperature (est.)	UL746B	°F	482
Electrical			
◆ Dielectric strength (100µ film)	ASTM D149	V/Mil	3,600
◆ Dielectric constant: 50Hz-10kHz, 0-300°F	ASTM D150		3.2-3.3
50Hz, 392°F			4.5

Fortron®
Polyphenylene Sulfide (PPS)

Product Data Sheet

Engineering Plastics Division

Fortron 0205P4, 0214P1, 0300P0 *

Pelletized unfilled PPS (Various Flow Grades)

PROPERTY Specimens @ 275F Mold Temp	ASTM Methods	Units (Eng.)	Values
Physical			
Specific Gravity	D-792		1.35
Water Absorption; 24 Hrs. Imms. @ rm.temp.	D-570	%	0.01
Mold Shrinkage:			
Flow/Transverse Direction		mil/in.	10-12/8-10
Mechanical @ 73F (23C)			
Tensile Strength	D-638	kpsi	12.5
Elongation	D-638	%	3.0 - 6.0
Flexural Strength	D-790	kpsi	21.0
Flexural Modulus	D-790	Mpsi	0.6
Rockwell Hardness	D-785	M-Scale	93
Izod Impact Strength: Notched	D-256	ft-lb/in	0.5
Unnotched	D-256	ft-lb/in	11.0
Thermal			
Heat Deflection Temp.:@ 66 psi	D-648	deg C (F)	105 (221)
@ 264 psi	D-648	deg C (F)	198 (390)
Electrical			
Dielectric Strength: @ 50%RH, 73 F - 1/8 in. thick	D-149	Volts/mil	450
Dielectric Constant @ 73 F: 1KHz	D-150	-	3.0
1MHz			3.0
Dissipation Factor @ 73 F: 1KHz	D-150	-	0.001
1MHz			0.0009
Volume Resistivity	D-257	ohm-cm	10^16
Arc Resistance	D-495	seconds	124

* These properties are also comparable to the granulate grades (0205B4, 0214B1, 0300B0) The 'B' denotes granulate form.

Recommended Injection Molding Setup Conditions

	Unreinforced Grades 0205P4, 0214P2	Reinforced Grades 1130 Series, 1140 Series, 4184 Series, 6165 Series
Melt Temperature, °F (°C)	560-620 (293-327)	590-640 (310-338)
Mold Temperature, °F (°C)	275-325 (135-163)	275-325 (135-163)
Injection Pressure, psi (MPa)	2000-6000 (13.8-41.4)	5000-10000 (34.5-69.0)
Back Pressure, psi (MPa)	0 (0)	0 (0)
Screw Speed, rpm	40-100	40-100
Cushion, in. (mm)	1/8-1/4 (3.18-6.35)	1/8-1/4 (3.18-6.35)
Drying Conditions	3 hours @250°F (121°C)	3-4 hours @ 275°F (135°C)

Recommended Extrusion Setup Conditions

	Unreinforced Grades 0214 Series, 0300 Series	Reinforced Grades 1140A0
Feed Zone Temperature, °F (°C)	545-555 (285-290)	555-575 (290-300)
Transition Zone Temperature, °F (°C)	555-565 (290-295)	555-590 (290-310)
Metering Zone Temperature, °F (°C)	555-575 (290-300)	570-610 (300-320)
Adapter Temperature, °F (°C)	570-590 (300-310)	570-610 (300-320)
Die Temperature, °F (°C)	570-590 (300-310)	570-610 (300-320)
Melt Temperature, °F (°C)	560-620 (293-327)	580-640 (304-338)
Typical Draw-down	2:1	2:1
Drying Conditions	3 hours @250 °F (121°C)	4 hours @ 270 °F (132°C)

Fortron® PPS Processing Benefits

- High melt flow, fast cycle grades improve productivity
- New grades can reduce or eliminate deflashing and exhibit lower flash compared to conventional PPS resins.
- Easily fills long, thin-walled parts.
- Processes very well on wide variety of injection molding equipment including hydraulic and toggle machines.
- Grades have low moisture absorption which improves resin transport in the feed section and reduces "bridging" in the hopper.
- Extrusion grades are available for fiber and monofilament production as well as tubing, rod and slab.

PRELIMINARY DATA

RADEL®
POLYPHENYLSULFONE

RADEL® R-5000, R-5100 NT15, and R-5700 Engineering Resins

RADEL R polyphenylsulfone resins offer exceptional hydrolytic stability similar to UDEL® polysulfone with greatly improved toughness, higher heat deflection temperature, and better resistance to stress cracking. The polymer also has excellent thermal stability, good electrical properties, and desirable combustion characteristics. RADEL R resins are available as a general purpose grade – R-5100 NT15, a transparent grade – R-5000, and a higher-flow transparent grade – R-5700. All grades are readily injection moldable to close tolerances.

DRYING

RADEL R polyphenylsulfone resins must be dried completely prior to melt processing. Incomplete drying will result in defects in the formed part ranging from surface streaks to severe bubbling. However, such parts may be recovered as regrind, since there will be no loss of properties. Pellets of RADEL R resins can be dried on trays in a circulating air oven or in a hopper dryer. Recommended drying conditions are 300°F (149°C) for 2.5 hours.

INJECTION MOLDING

RADEL R-5000, R-5100 NT15, and R-5700 resins can be readily injection molded in most screw injection machines. Stock temperature requirements will generally range from 680 to 735°F (360 to 390°C), depending on mold design and the type of equipment being used. A general purpose 2.2:1 compression screw is recommended, with minimum back pressure. Injection speeds should be as fast as possible, consistent with part appearance requirements. Mold temperatures of at least 280°F(138°C) are suggested, and as high as 300 to 325°F (150 to 165°C) in the case of long-flow or thin-walled parts, or where low residual stresses are required.

STANDARD PACKAGING LABELING

RADEL R resins are packaged in multiwall paper bags containing 25 kg (55.1 pounds) of material. Special packaging can be supplied upon request. Individual packages will be plainly marked with the product number, the color, the blend number, and the net weight.

PRECAUTIONARY LABELING

On the basis of the toxicological, physical, and chemical properties of RADEL R polyphenylsulfone resins, labeling used on containers is as follows:

Caution! Handling and/or processing this material may generate a dust which can cause mechanical irritation of the eyes, skin, nose, and throat.

PRODUCT SAFETY INFORMATION / EMERGENCY SERVICE

For product safety information on a product of Amoco Performance Products, Inc., call:

Material Safety Data Sheet
(312) 856-2934

Other Product Safety Information
(312) 856-3304

For information or help in an emergency such as a spill, leak, fire or explosion, call day or night:

Emergency Health Information
(800) 447-8735

Emergency Spill Information,
CHEMTREC (800)424-9300

Amoco Performance Products, Inc.
4500 McGinnis Ferry Road, Alpharetta, GA 30202-3914

TYPICAL PROPERTIES OF RADEL R-5000, R-5100 NT15, and R-5700 RESINS

Properties	ASTM Test Method	TYPICAL VALUES[1] R-5000		R-5100 NT15		R-5700	
General							
Specific Gravity	D-792	1.29		1.30		1.29	
Water Absorption, 24 hours, %	D-570	0.37		0.37		0.37	
Water Absorption at Equilibrium, %	D-570	1.1		1.1		1.1	
Refractive Index		1.672				1.672	
Mechanical							
Tensile Strength, psi (MPa)	D-638	10,100	(69.6)	10,100	(69.6)	10,100	(69.6)
Tensile Modulus, psi (GPa)	D-638	340,000	(2.34)	340,000	(2.34)	340,000	(2.34)
Tensile Elongation at yield, %	D-638	7.2		7.2		7.2	
Tensile Elongation at break, %	D-638	60-120		60-120		60-120	
Flexural Strength, psi (MPa)	D-790	13,200	(91)	13,200	(91)	13,200	(91)
Flexural Modulus, psi (GPa)	D-790	350,000	(2,410)	350,000	(2,410)	350,000	(2,410)
Tensile Impact Strength, ft-lb/in^2 (kJ/m^2)	D-1822	190	(400)	190	(400)	190	(400)
Izod Impact, Notched, ft-lb/in (J/m)	D-256	13	(690)	13	(690)	13	(690)
Thermal							
Heat Deflection Temperature, at 264 psi (1.82 MPa), °F (°C)	D-648	405	(207)	405	(207)	405	(207)
Flammability Rating[2] at 0.062 in. (1.6 mm)	UL-94	V-0		V-0		V-0	
Coefficient of Thermal Expansion, in/in°F (mm/mm°C) x 10^{-5}	D-696	3.1	(1.7)	3.1	(1.7)	3.1	(1.7)
Glass Transition Temperature[3], °F (°C)		428	(220)	428	(220)	428	(220)
Electrical							
Dielectric Strength, V/mil (kV/mm)	D-149	360	(15)	360	(15)	360	(15)
Dielectric Constant @ 60 Hz	D-150	3.44		3.44		3.44	
Volume Resistivity, ohm-cm	D-257	9 x 10^{15}		9 x 10^{15}		9 x 1015	
Chemical							
Steam Sterilization[4] w/ Morpholine, cycles passed without cracking, crazing, or rupture		>1000		>1000		>1000	
Fabrication							
Melt Flow at 752°F (400°C), 44 psi (0.3 MPa), g/10 min.	D-1238	14		14		19	
Mold Shrinkage, %	D-955	0.7		0.7		0.7	

[1] Typical values, actual properties of individual batches will vary within specification limits.

[2] These flammability ratings are not intended to reflect hazards presented by these or any other materials under actual fire conditions. Tests were conducted by Amoco Performance Products in conformance with UL-94 test methods.

[3] Measured by differential scanning calorimetry at a heating rate of 36°F (20°C) per minute.

[4] Steam Autoclave Conditions : Temperature - 270°F (132°C); Time - 30 minutes/cycle; Steam Pressure - 27 psig (0.19 MPa); Stress Level - 1000 psi (7.0 MPa) in flexure; Additive - Morpholine at 50 ppm.

Please direct orders to:

Customer Service Department
Amoco Performance Products, Inc.
4500 McGinnis Ferry Road
Alpharetta, GA 30202

AMOCO

PRODUCT DATA

RADEL®
POLYETHERSULFONE

recommended

RADEL A-100, A-200 and A-300 Engineering Resins

RADEL A-100 and A-200 polyethersulfones are the general purpose molding grades, and RADEL A-300 the high flow molding grade of the RADEL engineering resin family. All grades are transparent and offer high heat deflection temperature, thermal stability for extended use, excellent toughness, and exceptional creep resistance. They provide superior resistance to steam and boiling water, good stress crack resistance, good electrical properties, and desirable combustion characteristics. All grades are injection-moldable to close tolerances. RADEL A -300 resin offers higher melt flow, advantageous for molding thin-wall parts.

DRYING

RADEL A-100, A-200 and A-300 polyethersulfone resins must be dried completely prior to melt processing. Incomplete drying will result in defects in the formed part ranging from surface streaks to severe bubbling. However, such parts may be recovered as regrind, since there will be no loss of properties. Pellets of all RADEL grades can be dried on trays in a circulating air oven or hopper dryer. Drying conditions recommended are 2.5 hours at 350°F(177°C) .

INJECTION MOLDING

RADEL A-100, A-200 and A-300 resins can be readily injection molded in most screw injection machines. Stock temperature requirements will generally range from 650 to 725°F (343 to 385°C), depending on mold design and the type of equipment being used. A general purpose, 2.2:1 compression screw is recommended, with minimum back pressure. Injection speeds should be as fast as possible, consistent with part appearance requirements. Mold temperatures of at least 280°F(138°C) are suggested, and temperatures as high as 300-325°F(150-163°C) can be used for long-flow or thin-walled parts, or where low residual stresses are required.

STANDARD PACKAGING LABELING

RADEL A resins are packaged in multiwall paper bags containing 25 kg (55.1 pounds) of material. Special packaging can be supplied upon request.

Individual packages will be plainly marked with the product number, the color, the blend number, and the net weight.

PRECAUTIONARY LABELING

On the basis of the toxicological, physical, and chemical properties of RADEL A-100, A-200 and A-300 polyethersulfone resins, labeling used on containers is as follows:

Caution! Handling and/or processing this material may generate a dust which can cause mechanical irritation of the eyes, skin, nose, and throat.

PRODUCT SAFETY INFORMATION / EMERGENCY SERVICE

For product safety information on a product of Amoco Performance Products, Inc., call:

Material Safety Data Sheet
(312) 856-2934

Other Product Safety Information
(312) 856-3304

For information or help in an emergency such as a spill, leak, fire or explosion, call day or night:

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(800) 447-8735

Emergency Spill Information,
CHEMTREC (800) 424-9300

Amoco Performance Products, Inc.
4500 McGinnis Ferry Road, Alpharetta, GA 30202-3914

TYPICAL PHYSICAL PROPERTIES OF RADEL A-100, A-200, and A-300 RESINS

Properties	ASTM Test Method	TYPICAL VALUES[1] U.S. Customary units Value	Units	SI units Value	Units
General					
Specific Gravity	D 792	1.37		1.37	
Water Absorption, 24 hours	D 570	1.85	%	1.85	%
Mechanical					
Tensile Strength	D 638	12,000	psi	83	MPa
Tensile Modulus	D 638	385,000	psi	2.6	GPa
Tensile Elongation at yield	D 638	6.5	%	6.5	%
Flexural Strength	D 790	16,100	psi	111	MPa
Flexural Modulus	D 790	420,000	psi	2.9	GPa
Tensile Impact Strength	D 1822	160	ft-lb/in^2	336	kJ/m2
Izod Impact Strength	D 256	1.6	ft-lb/in	85	J/m
Thermal					
Heat Deflection Temperature, at 264 psi (1.82 MPa)	D 648	400	°F	204	°C
Flammability Rating[2] at thickness	UL-94	V-0 @ 0.031	in.	V-0 @ 0.8	mm
Coefficient of Thermal Expansion	D 696	2.7 x 10^{-5}	in/in°F	4.9 x 10^{-5}	mm/mm°C
Electrical					
Dielectric Strength	D 149	380	V/mil	15	kV/mm
Dielectric Constant	D 150				
@ 60 Hz		3.51		3.51	
@ 10^3 Hz		3.50		3.50	
@ 10^6 Hz		3.54		3.54	
Dissipation Factor	D 150				
@ 60 Hz		0.0017		0.0017	
@ 10^3 Hz		0.0022		0.0022	
@ 10^6 Hz		0.0056		0.0056	
Volume Resistivity	D 257	1.7 x 10^{15}	ohm-cm	1.7 x 10^{15}	ohm-cm
Fabrication					
Melt Flow at 380°C (716°F), 44 psi	D 1238				
A-100		12.5	g/10 min	12.5	g/10 min
A-200		20	g/10 min	20	g/10 min
A-300		30	g/10 min	30	g/10 min
Mold Shrinkage,	D 955	0.006	in/in	0.006	mm/mm

[1] Actual properties of individual batches will vary within specification limits.

[2] These flammability ratings are not intended to reflect hazards presented by these or any other materials under actual fire conditions.

Please direct orders to:

Customer Service Department C-2
Call (800) 621-4557 for technical information or
(800) 848-9744 to place orders.

TABLE 1 • TYPICAL PROPERTIES OF **UDEL®** POLYSULFONE GRADES OF PRODUCTS

PROPERTY		ASTM Methods	VALUE				
			P-1700	P-1700FR	P-1710	P-1720	P-3500
	Appearance in Natural Form	–	Natural 11 transparent light amber. Available in opaque and transparent colors.	Natural, translucent.	Natural 15 light beige opaque.	Natural 13 light beige translucent.	Natural 11 transparent light amber. Available in opaque and transparent colors.
	APPLICATION		General purpose, transparent, FDA	UL94 V-O grade	General purpose, opaque, FDA	UL94 V-O grade	Extrusion
GENERAL	Melt Flow, at 650°F (343.3°C), 44 psi (0.30 MPa), g/10 minutes	D 1238	6.5	6.5	6.5	6.5	3.5
	Density, Mg/m³	D 1505	1.24	1.24	1.25	1.25	1.24
	Mold Shrinkage, in/in or mm/mm	D 955	0.007	0.007	0.007	0.007	0.007
	Water Absorption, % in 24 hours	D 570	0.3	0.3	0.3	0.3	0.3
MECHANICAL	Tensile Strength at Yield, psi (MPa)	D 638	10,200 (70.3)	10,200 (70.3)	10,200 (70.3)	10,000 (68.9)	10,200 (70.3)
	Tensile Modulus, psi (MPa)	D 638	360,000 (2,482)	360,000 (2,482)	360,000 (2,482)	360,000 (2,482)	360,000 (2,482)
	Tensile Elongation at Break, %	D 638	50-100	50-100	50-100	50-100	50-100
	Flexural Strength, psi (MPa)	D 790	15,400 (106.2)	15,400 (106.2)	15,400 (106.2)	15,400 (106.2)	15,400 (106.2)
	Flexural Modulus, psi (MPa)	D 790	390,000 (2,689)	390,000 (2,689)	390,000 (2,689)	390,000 (2,689)	390,000 (2,689)
	Izod Impact, at 72°F (22°C), 1/8-in (3.2 mm) Specimen, ft-lb/in notch (J/m)	D 256	1.3 (69)	1.3 (69)	1.3 (69)	1.3 (69)	1.3 (69)
	Izod Impact, at -40°F (-40°C), 1/8-in (3.2 mm) Specimen, ft-lb/in notch (J/m)	D 256	1.2 (64)	1.2 (64)	1.2 (64)	1.2 (64)	1.2 (64)
	Tensile Impact, ft-lb/in² (kJ/m²)	D 1822	200 (421)	200 (421)	200 (421)	160 (336)	200 (421)
	Rockwell Hardness	D 785	M69 (R120)	M69 (R120)	M69 (R120)	M69 (R120)	M69 (R120)
THERMAL	Heat Deflection Temp., at 264 psi (1.8 MPa), °F (°C)	D 648	345 (174)	345 (174)	345 (174)	345 (174)	345 (174)
	Coefficient of Linear Thermal Expansion, in/in - °F mm/mm - °C	D 696	3.1×10^{-5} 5.6×10^{-5}	3.1×10^{-5} 5.6×10^{-5}	3.1×10^{-5} 5.6×10^{-5}	3.1×10^{-5} 5.6×10^{-5}	3.1×10^{-5} 5.6×10^{-5}
	Flammability(*) Average Time of Burning (ATB), seconds	D 635	5	5	5	<5	5
	Average Extent of Burning (AEB), in (mm)	D 635	0.4 (10)	0.4 (10)	0.4 (10)	<0.2 inch (<5)	0.4 (10)
		UL (File No. E-36098A)	0.058 in (1.47 mm) thickness: 94 HB 0.120 in (3.05 mm) thickness: 94 HB 0.176 in (4.47 mm) thickness: 94 V-O	0.110 inch (2.80 mm) thickness: 94V-0 (**)	0.058 in (1.47 mm) thickness: 94 HB 0.120 in (3.05 mm) thickness: 94 HB 0.176 in (4.47 mm) thickness: 94 V-O	0.040-inch (1.02 mm) thickness: 94V-1, 0.058 in (1.47 mm) inch and thicker: 94V-0	–
	Oxygen Index Rating	D 2863T	30	33	30	32	30
	Thermal Conductivity, Btu-in/ft² hr-°F (W/m-°C)	C 177	1.8 (0.26)	1.8 (0.26)	1.8 (0.26)	1.8 (0.26)	1.8 (0.26)
ELECTRICAL	Dielectric Strength, 130 mils Specimen, S/T, v/mil	D 149	425	425	425	370	425
	Arc Resistance, sec. (Tungsten Electrodes)	D 495	122	122	122	60	122
	Volume Resistivity at 72°F (22°C), ohm-cm	D 257	5×10^{16}	5×10^{16}	5×10^{16}	5×10^{16}	5×10^{16}
	Dielectric Constant at 72°F (22°C), 60 Hz-1 MHZ	D 150	3.07-3.03	3.07-3.03	3.07-3.03	3.15-3.06	3.07-3.03
	Dissipation Factor at 72°F (22°C), 60 Hz-1 MHZ	D 150	0.0008-0.0034	0.0008-0.0034	0.0008-0.0034	0.0008-0.0056	0.0008-0.0034

(*) NOTE: This numerical flame spread rating is not intended to reflect hazards presented by this or any other material under actual fire conditions.

(**) Anticipated rating, awaiting UL approval.

K-Resin®

PHILLIPS 66

TELEFAX

TO: Larry Wasicek

COMPANY: ACS

TELEPHONE: 408-235-3568

FAX #: 408-235-3333

SPECIAL INSTRUCTIONS: KR03/04/05 & KK38
Data sheets to follow at the request

K-Resin®

Data Sheet

PHILLIPS 66

K-Resin® Styrene-Butadiene Copolymers KR03 Grade

Customer Benefits

This SB copolymer is easily processed by injection molding or sheet extrusion and molded parts give excellent part detail on fast production cycles. It can be tinted or colored in a variety of transparent and opaque shades.

Molded parts have...

- Excellent clarity
- Good toughness
- Excellent rigidity

This copolymer is also available in a no-wax (NW) formulation to facilitate printing and decorating.

This copolymer is also offered in a sheet extrusion grade (SE) which provides greater antiblock performance.

Suggested Applications

Molded applications include...

- Molded boxes and containers
- Toys
- Displays
- Medical devices
- Overcaps
- Novelties

Formed applications include...

- Portion packages
- Blister packaging

Processing Recommendations

Maintain these conditions for optimum part quality...

- Injection Molding – Melt Temperature, 450°F *(232°C)* maximum. Screw plasticizing type injection molder more desirable than plunger type molder. Generally no need to dry resin.
- Sheet Extrusion – Melt Temperature, 420°F *(216°C)* maximum. High sheer and restrictive screws tend to degrade the melt. Generally, no need to dry resin.

Specifications

Meets these important requirements...

- USP Class VI-50
- FDA Regulation 21 CFR 177.1640. Suitable for contact

K-Resin

Recommended

Nominal Physical Properties of KR03 SB Copolymer

Property	ASTM	ENGLISH Unit	ENGLISH Value	SI Unit	SI Value
Density	D792	g/cc	1.01	g/cc	1.01
Flow Rate, Condition G	D1238	g/10 min	8.0	g/10 min	8.0
Tensile Yield Strength 2 in *(50 mm)* per min*	D638	psi	X 3700	MPa	26
Elongation, 2 in *(50 mm)* per min*	D638	%	(160)	%	160
Flexural Modulus*	D790	psi	X 205,000	MPa	1413
Flexural Yield Strength*	D790	psi	4900	MPa	34
Heat Deflection Temperature 264 psi *(1.8 MPa)* Fiber Stress	D648	°F	163	°C	73
Izod Impact Strength, Notched 1/8 in *(3.2 mm)* Specimen	D256	ft-lbf/in	0.75	J/m	41
Hardness, Shore D	D2240	–	X 65	–	65
Vicat Softening Point	D1525	°F	188	°C	87
Light Transmission	--	%	90	%	90
Moisture Absorption, 24 h	D570	%	X 0.09	%	0.09

**Specimen injection molded by ASTM Method D1897.*

THE NOMINAL PROPERTIES HEREIN ARE TYPICAL OF THE PRODUCT BUT DO NOT REFLECT NORMAL TESTING VARIANCE AND, THEREFORE, SHOULD NOT BE USED FOR SPECIFICATION PURPOSES.

July, 1992

For more information and technical assistance contact:
PHILLIPS PETROLEUM COMPANY
P.O. BOX 58966
HOUSTON, TX 77258-8966
1-800-231-1212
1-800-392-2078 (in Texas)

APPLICATION SPECIFIC COPOLYMERS

K-Resin®

Data Sheet

PHILLIPS 66

K-Resin® Styrene-Butadiene Copolymers KR04 Grade

Customer Benefits

This SB copolymer is easily processed by extrusion giving excellent part detail on fast production cycles and is designed for blending with general purpose polystyrene.

Extruded parts have ...

- Excellent clarity
- Good toughness
- Excellent rigidity

This copolymer is also available in a no-wax (NW) formulation to facilitate printing and decorating.

Suggested Applications

Major applications include . . .

- Thermoformed blister packs
- Disposable containers
- Portion packages

Processing Recommendations

Maintain these conditions for optimum part quality ...

- Melt temperature, 420°F *(216°C)* maximum. High shear and restrictive type screws tend to degrade the melt. Generally no need to dry resin.

Specifications

Meets these important requirements ...

- USP Class VI-50
- FDA Regulation 21 CFR 177.1640. Suitable for contact with non-fatty foods.

K-Resin®

Nominal Physical Properties of KR04 SB Copolymer

Property	ASTM	ENGLISH Unit	ENGLISH Value	SI Unit	SI Value
Density	D792	g/cc	1.01	g/cc	1.01
Flow Rate, Condition G	D1238	g/10 min	8.0	g/10 min	8.0
Tensile Yield Strength 2 in (50 mm) per min*	D638	psi	3700	MPa	26
Elongation, 2 in (50 mm) per min*	D638	%	160	%	160
Flexural Modulus*	D790	psi	205,000	MPa	1413
Flexural Yield Strength*	D790	psi	4900	MPa	34
Heat Deflection Temperature 264 psi (1.8 MPa) Fiber Stress	D638	°F	163	°C	73
Izod Impact Strength 1/8 in (3.2 mm) Specimen	D256	ft-lbf/in	0.75	J/m	41
Hardness, Shore D	D2240		65		65
Vicat Softening Point	D1525	°F	188	°C	87
Light Transmission	–	%	90	%	90
Moisture Absorption, 24 h	D570	%	0.09	%	0.09

Specimen injection molded by ASTM Method D1897.

THE NOMINAL PROPERTIES REPORTED HEREIN ARE TYPICAL OF THE PRODUCT BUT DO NOT REFLECT NORMAL TESTING VARIANCE AND, THEREFORE, SHOULD NOT BE USED FOR SPECIFICATION PURPOSES.

November, 1991

For more information and technical assistance contact:
PHILLIPS 66 COMPANY
P.O. BOX 58966
HOUSTON, TX 77258-8966
1-800-231-1212
1-800-392-2078 (in Texas)

APPLICATION SPECIFIC COPOLYMERS

PHILLIPS 66

K-Resin®

Data Sheet

PHILLIPS 66

K-Resin® Styrene Butadiene Copolymers KR05 Grade

Customer Benefits

This resin is easily processed on blow molding, extrusion, and blown film or cast film equipment.

Finished products have...

- Excellent clarity
- Good toughness
- Good stiffness
- High surface gloss
- Good heat sealability of film

Suggested Applications

Major applications include...

- Bottles and containers
- Shrink wrap
- Tamper resistant packaging
- Produce wrap
- Medical packaging
- Overwrap film
- Lidding film
- Twist wrap

Processing Recommendations

Maintain these conditions for optimum product quality...

- Extrusion – Melt Temperature, 420°F *(216°C)* maximum. High shear and restrictive type screws tend to degrade the melt.
- Blow Molding – 370–385°F *(188–196°C)* for maximum melt strength. Generally no need to dry resin.
- Film – Stock Temperature, 350 – 400°F *(177 – 294°C)*. High shear and restrictive screws tend to degrade the melt.

Specifications

Meets these important requirements...

- USP Class VI-50
- FDA Regulation 21 CFR 177.1640. Suitable for contact with non-fatty foods.

K-Resin®

Nominal Physical Properties of KR05 SB Copolymer

Property	ASTM	ENGLISH Unit	ENGLISH Value	SI Unit	SI Value
Density	D792	g/cc	1.01	*g/cc*	*1.01*
Flow Rate, Condition G	D1238	g/10 min	8.0	*g/10 min*	*8.0*
Tensile Yield Strength, 2 in *(50 mm)* per min*	D638	psi	3700	*MPa*	*26*
Elongation, 2 in *(50 mm)* per min*	D638	%	160	%	*160*
Flexural Modulus* (secant)	D790	psi	205,000	*MPa*	*1413*
Flexural Yield Strength*	D790	psi	4900	*MPa*	*34*
Heat Deflection Temperature 264 psi *(1.8 MPa)* Fiber Stress	D638	°F	163	°C	*73*
Izod Impact Strength 1/8 in *(3.2 mm)* Specimen	D256	ft-lbf/in	0.75	*J/m*	*41*
Hardness, Shore D	D2240	–	65	–	*65*
Vicat Softening Point	D1525	°F	188	°C	*87*
Light Transmission	–	%	90	%	*90*
Moisture Absorption, 24 h	D570	%	0.09	%	*0.09*
Typical Blown Film Properties, 1 mil *(0.025 mm)*, 2:1 Blow up Ratio, 35 mils Die Gap					
Tensile Yield Strength	D882				
MD		psi	3800	*MPa*	*26*
TD			2300		*16*
Elongation	D882				
MD		%	150	%	*150*
TD			240		*240*
Dart Drop, 26 in *(66mm)*	D1709	g	400	*g*	*400*
Elmendorf Tear	D1922				
MD		g	15	*g*	*15*
TD			19		*19*
Shrinkage	–				
MD		%	73	%	*73*
TD			24		*24*
Haze	D1003	%	2	%	*2*
Light Transmission	D1003	%	90	%	*90*
Gloss	D523	%	155	%	*155*
Crease Retention	TAPPI T446-B	%	100	%	*100*
Typical Barrier Properties					
Moisture Vapor Transmission	E96	g-mil/100in²-24h	6.8	*g-mm/m²-24h*	*2.7*
Gas Transmission Rate	D1431	cc-mil/100in²-24h		*cc-mm/m²-24h*	
O_2			500		*197*
N_2			66		*26*
CO_2			2170		*854*

**Specimen injection molded by ASTM Method D1897.*

THE NOMINAL PROPERTIES HEREIN ARE TYPICAL OF THE PRODUCT BUT DO NOT REFLECT NORMAL TESTING VARIANCE AND, THEREFORE, SHOULD NOT BE USED FOR SPECIFICATION PURPOSES.

October, 1993

For more information and technical assistance contact:
PHILLIPS PETROLEUM COMPANY
P.O. BOX 58966
HOUSTON, TX 77258-8966
1-800-231-1212
1-800-392-2078 (in Texas)

APPLICATION SPECIFIC COPOLYMERS PHILLIPS 66

K-Resin®

Data Sheet

PHILLIPS 66

K-Resin® SB Copolymers KK38 Developmental Grade

Customer Benefits

KK38 is an improved extrusion grade K-Resin® copolymer designed specifically for superior performance in blends with general purpose polystyrene. It is easily processed by extrusion and gives thermoformed parts with excellent detail on fast production cycles.

Compared to KR04, KK38 offers...

- Greater polystyrene acceptance with equivalent processability

Thermoformed parts have...

- Very good clarity
- Excellent toughness
- Good stiffness

Suggested Applications

Major applications include...

- Thermoformed blister packs
- Cups and lids
- Portion packages

Processing Recommendations

Maintain these conditions for optimum quality...

- Melt temperature, 420°F *(216°C)* maximum. High shear and restrictive type screws tend to degrade the melt. Generally no need to dry resin.

Specifications

Meets this important requirement...

- When combined with at least 50% polystyrene to produce articles for food contact, KK38 complies with FDA Regulation 21 CFR 177.1640.

K-Resin®

Nominal Physical Properties of KK38 Copolymer

Property	ASTM	ENGLISH Unit	ENGLISH Value	SI Unit	SI Value
Density	D792	g/cc	1.00	*g/cc*	*1.00*
Flow Rate, Condition G	D1238	g/10 min	9.0	*g/10 min*	*9.0*
Tensile Yield Strength 2 in *(50 mm)* per min*	D638	psi	1900	*MPa*	*13.1*
Elongation to Break 2 in *(50 mm)* per min*	D638	%	180	*%*	*180*
Flexural Modulus*	D790	psi	153,000	*MPa*	*1055*
Flexural Yield Strength*	D790	psi	2700	*MPa*	*18.6*
Heat Deflection Temperature 264 psi *(1.8 MPa)* Fiber Stress	D648	°F	143	*°C*	*62*
Izod Impact Strength, Notched 1/8 in *(3.2 mm)* Specimen	D256	ft-lbf/in	No Break	*J/m*	*No Break*
Hardness, Shore D	D2240	–	58	*–*	*58*
Vicat Softening Point	D1525	°F	169	*°C*	*76*
Light Transmission	–	%	89	*%*	*89*

**Specimen injection molded by ASTM Method D1897.*

THE NOMINAL PROPERTIES HEREIN ARE TYPICAL OF THE PRODUCT BUT DO NOT REFLECT NORMAL TESTING VARIANCE AND, THEREFORE, SHOULD NOT BE USED FOR SPECIFICATION PURPOSES.

May, 1992

For more information and technical assistance contact:
PHILLIPS 66 COMPANY
A DIVISION OF
PHILLIPS PETROLEUM COMPANY
P.O. BOX 58966
HOUSTON, TX 77258-8966
1-800-231-1212
1-800-392-2078 (in Texas)

APPLICATION SPECIFIC COPOLYMERS

PHILLIPS 66

177-92 01

K-Resin®

PHILLIPS 66

TELEFAX

TO: Larry Wasicek

COMPANY: ACS

TELEPHONE: 408-235-3568

FAX #: 408-235-3333

SPECIAL INSTRUCTIONS: KR03/04/05 & KK38 Data Sheets to follow at the request of Ted Randall.

Thank You

FROM: Betty Woods
2625 Bay Area Blvd.
Houston, TX 77058

TELEPHONE (713) 244-3057
FAX # (713) 244-3212

9 PAGE(S) INCLUDING COVER SHEET

K-Resin®

Data Sheet

PHILLIPS 66

K-Resin® Styrene-Butadiene Copolymers KR03 Grade

Customer Benefits

This SB copolymer is easily processed by injection molding or sheet extrusion and molded parts give excellent part detail on fast production cycles. It can be tinted or colored in a variety of transparent and opaque shades.

Molded parts have...

- Excellent clarity
- Good toughness
- Excellent rigidity

This copolymer is also available in a no-wax (NW) formulation to facilitate printing and decorating.

This copolymer is also offered in a sheet extrusion grade (SE) which provides greater antiblock performance.

Suggested Applications

Molded applications include...

- Molded boxes and containers
- Toys
- Displays
- Medical devices
- Overcaps
- Novelties

Formed applications include...

- Portion packages
- Blister packaging

Processing Recommendations

Maintain these conditions for optimum part quality...

- Injection Molding – Melt Temperature, 450°F *(232°C)* maximum. Screw plasticizing type injection molder more desirable than plunger type molder. Generally no need to dry resin.
- Sheet Extrusion – Melt Temperature, 420°F *(216°C)* maximum. High sheer and restrictive screws tend to degrade the melt. Generally, no need to dry resin.

Specifications

Meets these important requirements...

- USP Class VI-50

Specifications

Meets these important requirements...

- USP Class VI-50
- FDA Regulation 21 CFR 177.1640. Suitable for contact
- Portion packages

Processing Recommendations

Maintain these conditions for optimum part quality ...

- Melt temperature, 420°F *(216°C)* maximum. High shear and restrictive type screws tend to degrade the melt. Generally no need to dry resin.

Specifications

Meets these important requirements ...

- USP Class VI-50
- FDA Regulation 21 CFR 177.1640. Suitable for contact with non-fatty foods.

Customer Benefits

This resin is easily processed on blow molding, extrusion, and blown film or cast film equipment.

Finished products have...

- Excellent clarity
- Good toughness
- Good stiffness
- High surface gloss
- Good heat sealability of film

Suggested Applications

Major applications include...

- Bottles and containers
- Shrink wrap
- Tamper resistant packaging
- Produce wrap
- Medical packaging
- Overwrap film
- Lidding film
- Twist wrap

Processing Recommendations

Maintain these conditions for optimum product quality...

- Extrusion – Melt Temperature, 420°F *(216°C)* maximum. High shear and restrictive type screws tend to degrade the melt.
- Blow Molding – 370–385°F *(188–196°C)* for maximum

product quality...

- Extrusion – Melt Temperature, 420°F *(216°C)* maximum. High shear and restrictive type screws tend to degrade the melt.
- Blow Molding – 370–385°F *(188–196°C)* for maximum melt strength. Generally no need to dry resin.
- Film – Stock Temperature, 350–400°F *(177–294°C)*. High shear and restrictive screws tend to degrade the melt.

Specifications

Meets these important requirements...

- USP Class VI-50
- FDA Regulation 21 CFR 177.1640. Suitable for contact with non-fatty foods.

For more information and technical assistance contact:
PHILLIPS PETROLEUM COMPANY
P.O. BOX 58966
HOUSTON, TX 77258-8966
1-800-231-1212
1-800-392-2079 (in Texas)

APPLICATION SPECIFIC COPOLYMERS

PHILLIPS 66

STOPPED

Amoco Performance Products, Inc.
4500 McGinnis Ferry Road
Alpharetta, Georgia 30202-3914
404-772-8200

FAX TRANSMISSION

TO: LARRY WASICEK 120	FROM: *John Boyd*
COMPANY: ACS	COMPANY: *Amoco Performance Products, Inc. 4500 McGinnis Ferry Road Alpharetta, GA 30202*
DEPT:	TEL: *(404) 772-8734*
FAX: 408-235-3333	FAX: *(404) 772-8747*
DATE: 2-3-94	NUMBER OF PAGES: 4

ATOCHEM
elf aquitaine

Technical Information

Pebax® Resins

33 Series Property Comparison

Property	ASTM Test Method	Units	1147	7033	6333	5533	4033	3533	2533
Specific Gravity	D792		1.01	1.02	1.01	1.01	1.01	1.01	1.01
Water Absorption Equilibrium (20°C, 50% R.H.)	D570			0.64		0.5	0.5	0.5	0.5
24 Hr. Immersion				0.83		1.2	1.2	1.2	1.2
Hardness	D2240			69D	63D	55D	40D	35D	25D
Tensile Strength, Ultimate	D638	psi	9,063	8,300	8,100	7,300	5,700	5,600	4,950
Elongation, Ultimate	D638	%		400	300	430	390	580	640
Flexural modulus	D790	psi	133,000	67,000	49,000	29,000	13,000	2,800	2,100
Izod Impact, Notched 20°C	D250	ft.-lb./in.		NB	NB	NB	NB	NB	NB
-40°C				0.95	1.5	NB	NB	NB	NB
Abrasion Resistance H18/1000g	D1044	Mg/1000 Cyc.		57	84	93	94	104	161
Tear Resistance Notched	D624C	lb/in		900	850	650	400	260	220
Melting Point	D3418	°F	348	345	342	334	334	306	298
Vicat Softening Pt.	D1525	°F		329	322	291	270	165	140
HDT 66 psi	D648	°F		208	194	151	126	115	108
Compression Set (24 hr., 160° F)	D395A	%		6	6	10	21	54	62

EVAL®

Ethylene Vinyl Alcohol Copolymer Resins
Resins, Key Properties and Applications

	UNIT	TEST METHOD	RESIN GR
			L101
RECOMMENDED APPLICATIONS			Blown film, melt phase forming
Ethylene Copolymer Ratio	mol%		27
Melt Index	g/10 min	D1238 190°C 210°C	— 3.9
Density	g/cm³	D1505	1.20
THERMAL PROPERTIES			
Melting Point	°C °F	DSC	191 376
Crystallization Temperature	°C	DSC	167
Glass Transition Temperature	°C	Dynamic Viscoelasticity	72
PHYSICAL PROPERTIES			
Tensile Strength @ Break @ Yield	psi psi	D638, 10% min.	10,385 13,655
Elongation	%	D638, 10% min	200
Young's Modulus	psi	D638, 10% min	45.5×10^4
Rockwell Hardness	M	D785	104
Linear Expansion Rate	1/°C	Above Tg Below Tg	10.5×10^{-5} 4.0×10^{-5}
BARRIER PROPERTIES			
Oxygen Permeation	cm^3-mil/100g in^2, 24 hrs.	20°C, 65% RH 20°C, 85% RH 20°C, 100% RH	0.010 0.061 1.22
Water Vapor Transmission Rate	g-mil/100 in^2, 24 hrs.	40°C, 90% RH	6.5
EXTRUSION TEMPERATURE			
Melt Temperature, max.	°C °F	—	240 465

K102	E105	E151	G115	G156
olid phase 'essure rming	Cast film, melt phase forming, solid phase pressure forming, tubes, coex coating	Melt phase forming, solid phase pressure forming, blow molding, tubes	Cast film, specialty applications	Cast film, specialty applications
38	44	44	48	48
2.8 6.0	5.5 13.0	1.6 3.5	14.0 —	6.4 14.7
1.17	1.14	1.14	1.12	1.12
175 347	165 329	165 329	158 320	158 320
151	142	142	136	136
62	55	55	49	49
8,820 9,530	7,395 8,535	7,395 8,535	5,405 6,260	5,405 6,260
240	280	280	330	330
34.1 x 10^4	29.9 x 10^4	29.9 x 10^4	27.1 x 10^4	27.1 x 10^4
93	88	88	85	85
12 x 10^{-5} 7.0 x 10^{-5}	13 x 10^{-5} 8.0 x 10^{-5}	13 x 10^{-5} 8.0 x 10^{-5}	13 x 10^{-5} 10.0 x 10^{-5}	13 x 10^{-5} 10.0 x 10^{-5}
0.035 0.112 0.66	0.076 0.168 0.51	0.076 0.168 0.51	0.163 0.310 0.86	0.163 0.310 0.86
1.4	1.4	1.4	1.4	1.4
240 465	250 480	250 480	250 480	250 480

Physical property data developed by Kuraray Company, Ltd. and Quantum Chemical Corporation

F100	F101	F104	T102	H103	H151	K
Melt phase forming	Blown film, cast film, melt phase forming, blow molding	Cast film, blow molding, tubes, coex coating	Solid phase pressure forming	Cast film, coex coating	Blown film	Solid press formi
32	32	32	32	38	38	
0.8 1.9	1.6 3.8	4.4 10.5	2.1 5.0	3.8 8.4	1.6 3.8	2 6
1.19	1.19	1.19	1.18	1.17	1.17	1
183 361	183 361	183 361	183 361	175 347	175 347	1 3
161	161	161	161	151	151	1
69	69	69	69	62	62	
10,670 11,665	10,385 11,235	8,390 10,670	9,390 10,240	6,685 9,385	8,530 9,670	8, 9.
130	230	270	270	280	250	2
38.4×10^4	38.4×10^4	38.4×10^4	27.0×10^4	34.1×10^4	34.1×10^4	34.1
101	100	97	95	95	95	
11×10^{-5} 5.0×10^{-5}	11×10^{-5} 5.0×10^{-5}	11×10^{-5} 5.0×10^{-5}	12×10^{-5} 6.0×10^{-5}	12×10^{-5} 7.0×10^{-5}	12×10^{-5} 7.0×10^{-5}	12 7.0
0.020 0.076 0.97	0.020 0.076 0.97	0.020 0.076 0.97	0.025 0.091 0.76	0.025 0.112 0.66	0.035 0.112 0.66	0. 0. 0.
3.8	3.8	3.8	3.8	2.1	2.1	1.
240 465	240 465	240 465	240 465	240 465	240 465	2

ULTEM® resin CRS5000 Series Improved Chemical Resistant Grades

ULTEM CRS Resins are a highly chemical resistant family of high-performance amorphous thermoplastics based on polyetherimide (PEI) technology.

ULTEM CRS5011 Resin provides significantly improved chemical resistance over standard ULTEM 1000 resin. It also offers improved processability and enhanced performance in hot water.

ULTEM CRS5001 Resin offers the highest chemical resistance of all ULTEM resin grades and exhibits excellent performance in hot water. Processing characteristics are similar to ULTEM 1000 resin. ULTEM CRS5001 resin is also suitable for extrusion processing.

ULTEM CRS5001 resin: unreinforced
ULTEM CRS5011 resin: unreinforced, low viscosity
ULTEM CRS5101 resin: 10% glass reinforced
ULTEM CRS5111 resin: 10% glass reinforced, low viscosity
ULTEM CRS5201 resin: 20% glass reinforced
ULTEM CRS5211 resin: 20% glass reinforced, low viscosity
ULTEM CRS5301 resin: 30% glass reinforced
ULTEM CRS5311 resin: 30% glass reinforced, low viscosity

Typical Property Values

English Units (SI Units)

PROPERTY	ENG(SI) UNITS	TEST METHOD	ULTEM CRS5001 CRS5011[1] resins	ULTEM CRS5101 CRS5111[1] resins	ULTEM CRS5201 CRS5211[1] resins	ULTEM CRS5301 CRS5311[1] resins
MECHANICAL						
Tensile Strength, yield, Type I, 0.125" (3.2 mm)	psi(MPa)	ASTM D 638	14,500(100)	16,500(114)	20,000(138)	24,000(165)
Tensile Elongation, break, Type I, 0.125" (3.2 mm)	%	ASTM D 638	70.0	4.5	3.0	2.0
Tensile Modulus, Type I, 0.125" (3.2 mm)	psi(MPa)	ASTM D 638	420,000(2,896)	630,000(4,344)	930,000(6,412)	1,300,000(8,963)
Flexural Strength, yield, 0.125" (3.2 mm)	psi(MPa)	ASTM D 790	20,000(138)	28,000(193)	31,000(214)	33,000(228)
Flexural Modulus, 0.125" (3.2 mm)	psi(MPa)	ASTM D 790	450,000(3,103)	650,000(4,482)	1,000,000(6,895)	1,300,000(8,963)
Hardness, Rockwell R	—	ASTM D 785	123	—	—	—
IMPACT						
Izod Impact, unnotched, 0.125" (3.2 mm), 73F (23C)	ft-lb/in(J/m)	ASTM D 256	24.0(1,280)	—	—	—
Izod Impact, notched, 0.125" (3.2 mm), 73F (23C)	ft-lb/in(J/m)	ASTM D 256	1.0(53)	1.1(59)	1.6(85)	1.7(91)
Izod Impact, reverse notched, 0.125" (3.2 mm)	ft-lb/in(J/m)	ASTM D 256	39.0(2,080)	11.0(587)	9.0(480)	7.5(400)
THERMAL						
HDT, 264 psi (1.82 MPa), 0.250" (6.4 mm)	deg F(deg C)	ASTM D 648	408(209)	424(218)	430(221)	430(221)
PHYSICAL						
Specific Gravity, solid	—	ASTM D 792	1.28	1.35	1.42	1.51
Water Absorption, 24 hours @ 73F (23C)	%	ASTM D 570	0.16	—	—	—
ELECTRICAL						
Volume Resistivity	ohm-cm(ohm-m)	ASTM D 257	1.1E17(1.1E15)	—	—	—
Dielectric Strength, in oil, 62 mils (1.6 mm)	V/mil(kV/mm)	ASTM D 149	456(18)	—	—	—
Dielectric Constant, 100 Hz	—	ASTM D 150	3.12	—	—	—
Dissipation Factor, 100 Hz	—	ASTM D 150	0.0017	—	—	—
FLAME CHARACTERISTICS						
UL94V-0 Flame Class Rating*	in(mm)	UL 94	0.063(1.60)	0.063(1.60)	0.063(1.60)	0.063(1.60)
UL94-5VA Flame Class Rating*	in(mm)	UL 94	—	0.063(1.60)	0.063(1.60)	0.063(1.60)

*This rating is not intended to reflect hazards presented by this or any other material under actual fire conditions.
[1] Low viscosity version. Properties may vary slightly.